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U.S. NAVY ENERGY PLAN

(11) JANUARY 1977

Prepared for:
CHIEF OF NAVAL OPERATIONS

Prepared under the Direction of:
U. S. NAVY ENERGY OFFICE (OP-413)

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U.S. NAVY ENERGY OFFICE (OP-413)

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C.

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From: Chief of Naval Operations
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Encl: (1) U. S. Navy Energy Plan dated January 1977

1. Although the acute petroleum shortages which we experienced a few years ago have abated, our nation's dependence upon foreign sources of petroleum has, in fact, increased. It is essential that we maintain the momentum which has been developed in moving toward greater efficiency in the management and consumption of energy resources in the Navy.

2. The Navy Energy Plan, forwarded as enclosure (1), has been developed to provide you with the necessary background and the goals, strategies, objectives and policy to improve our energy utilization. A companion document, Navy Energy Research and Development (R&D) Plan, has also been developed to guide the projects and tasks being performed by the Naval Systems Commands (SYSCOM's), laboratories and related R&D facilities towards improved energy utilization.

3. I have tasked the Navy Energy Office (OPNAV-413) with the responsibility of coordinating the total Navy energy program. All hands are responsible for carrying out the objectives and policy outlined in the Navy Energy Plan to attain established energy management and utilization goals. Only through your efforts in implementing sound energy policy can we continue to meet our national security obligations.

J L Holloway III

J. L. HOLLOWAY III
Admiral, U.S. Navy

PREFACE

The Navy Energy Plan has been developed by the Navy Energy Office, OP-413, in coordination with the Navy Energy Action Group (EAG).

This plan reflects the current Navy energy programs and includes views and comments from fleet and shore commanders, the naval systems commands, and the Navy Natural Resources and Energy Research and Development Office relative to Navy energy problems.

EAG is responsible for keeping apprised of the Navy energy situation and recommending to CNO those additional energy objectives and policies that, if achieved, will have a direct impact on an improved military capability. Their recommendations will be included in revisions to this plan.

This initial Navy Energy Plan includes: EAG's and OPNAV's best assessment of the implications to the Navy of the national energy problem in the short-, mid-, and long-term; provides CNO with a framework (a centralized, coordinated, and explicit approach) to consider the continually developing energy situation; evaluates energy matters that affect the Navy's many interests; and provides overall Navy direction. Integrated energy goals, strategies, and objectives are established to assist program managers and fleet and shore commanders in evaluating and implementing various local policies and program activities.

At this stage of the plan, nuclear energy has not been considered. Development of nuclear energy sources is ERDA's responsibility and is closely monitored by the appropriate Navy offices. This does not preclude considering the impact that nuclear energy will have on alternative fuel requirements in the future. Because of the distinctive application of nuclear power in the Navy, nonnuclear energy issues should not be prejudiced if considered separately at this stage.

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EXECUTIVE SUMMARY

The Navy Energy Plan has been developed to ensure that the Navy's energy future is continually reexamined and reevaluated with regard to national and world energy perspectives.

The plan consists of energy goals, strategies, and objectives (as depicted in Figure 1), from which policy and program initiatives are evolved and implemented.

The Executive Summary includes:

- Required Natural Petroleum Resources to Support National Security.
- The Energy Situation in the Department of the Navy.
- Future Energy Requirements in the Department of the Navy.
- The Navy Energy Plan: New Initiatives.

REQUIRED NATURAL PETROLEUM RESOURCES TO SUPPORT NATIONAL SECURITY

Since 1965, the U.S. Geological Survey (USGS) has lowered its estimate of available domestic petroleum. It is possible that the total recoverable amount is between 112 billion and 189 billion barrels, under current technological and economic conditions. This estimate, when examined with recent projections of future increased consumption, indicates that natural petroleum will be depleted much earlier than was generally expected.

The effect of decreased domestic production on national security will be to increasingly rely on nonsecure foreign imports in the short- and mid-term. For the first time in history, during one week in March 1976, the United States imported a record level of more than one-half of its total oil requirements.

Estimates show that world natural crude oil production will probably peak about 1990. The impact of these projections on world geopolitical stability, although not readily calculable, could possibly yield major shifts in the world balance of power. Industrial and agricultural nations will be affected, since both depend on this energy resource to maintain their economies and standards of living.

National security and defense depend on available energy in all forms, particularly portable fuels to support worldwide commitments on the ground, in the air, and on the seas. The U.S. economy relies on an uninterrupted flow of goods and services. Transporting these goods and services depends on portable fuels, which, in turn, are part of national security. Although all sectors of the economy rely on energy, transportation

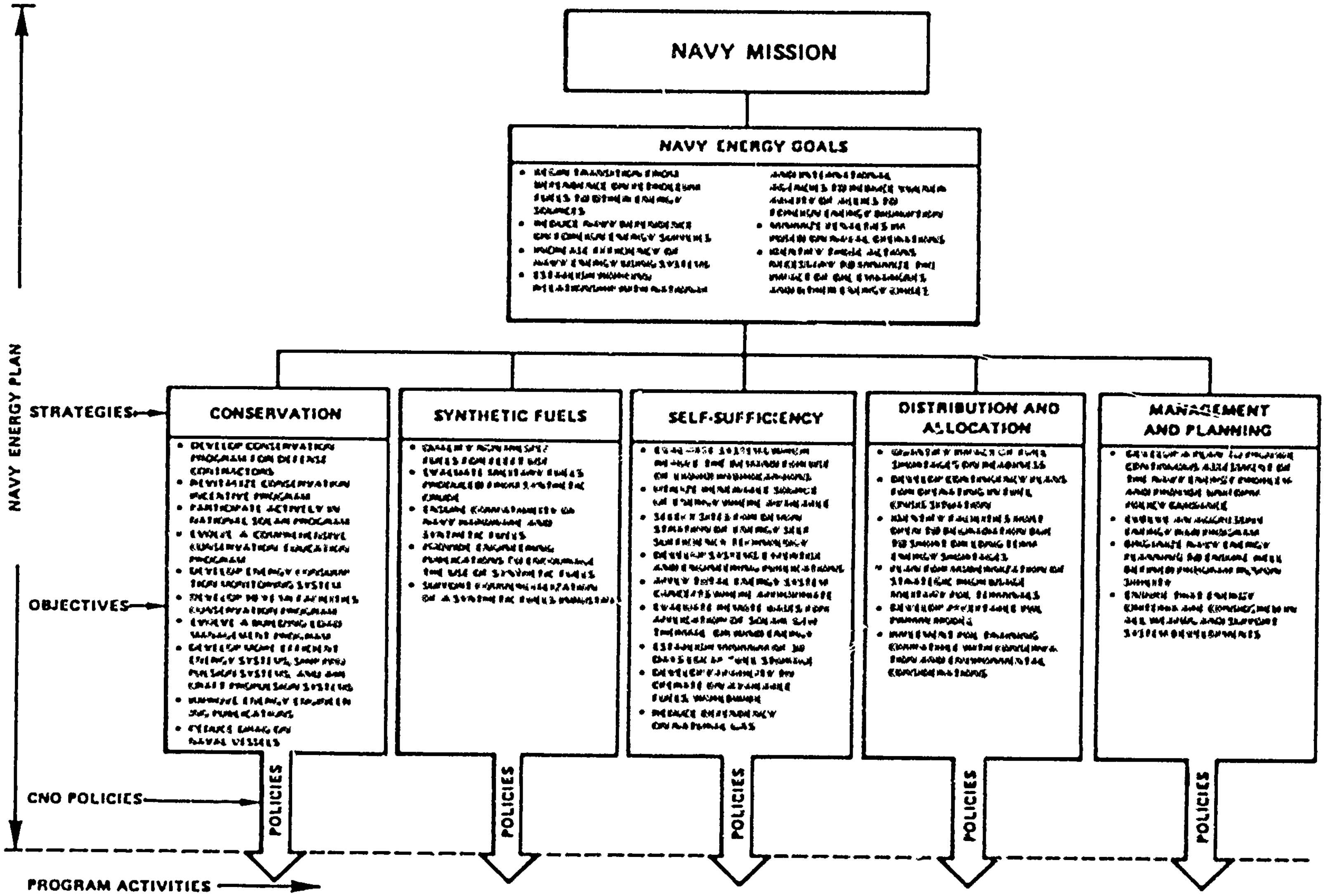


Figure 1. NAVY ENERGY PROGRAM ACTIVITY

alone almost completely (98 percent) depends on liquid petroleum. Other sectors may substitute energy sources in the future such as coal, geothermal, solar, and nuclear power; however, the options available to transportation and defense are severely limited. Major conservation efforts in these areas are important, although conservation alone will only marginally extend the projected depletion dates.

Solutions to minimizing U.S. dependence on liquid petroleum will be difficult. The problem is not that energy resources are unavailable. In the United States, there are vast amounts of ultimately recoverable oil shale resources, which total 1,065 billion barrels of oil equivalent (BBOE), and coal resources, which total 14,310 BBOE. These resources, which can potentially supply U.S. requirements in synthetic liquid fuels, far exceed the estimated 189 billion barrels of liquid petroleum. Experience in the Department of Defense (DOD) has shown, however, that major development projects, from concept to field use, take 8 to 13 years. Civilian estimates are about the same. Under the Administration's present policy, incentive structures and federal programs are lacking. Thus, synthetic liquid fuels for national defense will not be produced until after 1985. An accelerated program could probably yield 300,000 barrels to 500,000 barrels per day after a production schedule of 10 years. It might then be possible to produce millions of barrels per day in the late 1990s. However, an accelerated program would cause many problems involving financial incentives, water resources, transportation, environmental regulations, materials priorities, production capacities, and manpower training. These complex and politically sensitive problems largely overshadow the substantial technical problems. Since a variety of interests are involved, there must be an integrated national approach to technical, environmental, sociological, and economic issues. Although the Federal Energy Administration (FEA) and the Energy Research and Development Administration (ERDA) are trying to solve the technical problems, it is not certain that the other factors are receiving adequate attention or that the results will be timely.

Defense planning and operations depend on policies and actions of civilian agencies and industry to provide an alternative to natural petroleum fuels. Thus, it is extremely important that national security is considered by civilian agencies and industry and that their policies ensure that defense needs are met. Today, civilian agencies neither consider national defense in their major planning efforts nor do they follow any clear, coordinated national policy toward developing alternative fuels.

The prevailing U.S. tendency is to assume that market forces will bring about necessary actions and ultimate solutions to energy-related problems. The point where rising petroleum prices or new technology will make developing and producing alternative fuels a profitable commercial venture . highly speculative. There may not be enough investment capital and time to rely solely on market mechanisms. Quantitative relationships between petroleum prices and the economics of developing and producing alternative fuels are poorly understood or unknown.

Today, national policies and actions are based primarily on achieving independence from foreign petroleum supplies and balancing domestic supply and demand, rather than on recognizing the depleting supply of natural petroleum. It is possible that defense and transportation elements of national security may ultimately suffer from the absence of a fully integrated effort to supply necessary alternatives for natural petroleum fuels.

In conclusion, analyzing the domestic energy situation reveals certain implications that pertain to national security:

- Required quantities of domestic natural petroleum fuels will not be available beginning between 1985 and 1995.
- Defense and transportation elements of national security depend largely on secure and available portable fuels.
- Available portable fuels for future defense operations rely on nondefense efforts. Thus, federal energy programs must consider and should incorporate actions supporting national security needs.
- Relying on free market solutions may not be adequate when considering the time it takes to develop and evaluate new technologies, and the capital risk involved in new energy systems.
- Technical problems are overshadowed by other major problems. Those involved in the national political decision-making process must recognize, in dealing with future energy matters, that social, economic, environmental, and legal problems are equally complex and must be solved.
- Additional effort must be placed on a national integrated plan to develop alternative fuels to ensure that future national security requirements are met.
- Current Executive policies focus on energy independence rather than recognizing the depleting domestic petroleum supply. Greater emphasis is needed to communicate the problem to the public.
- The United States has reached a point of strategic transition whereby a shift must be made from relying primarily on natural petroleum to using alternative sources. This is the major issue that must be resolved.

THE ENERGY SITUATION IN THE DEPARTMENT OF THE NAVY

The Navy annually consumes (directly) about 78 million barrels of oil equivalent (MBOE), 33 percent by ships, 27 percent by aircraft, and 40 percent by shore activities. Energy consumed by the defense industry in supporting the Navy's requirements is probably between 100 MBOE and 200 MBOE annually.

The Navy achieved a 29.9 percent energy savings in FY 1976, compared with the baseline year of FY 1973. Figure 2 shows how those savings were made. Preliminary data indicates that the Navy attained a 10.5 percent savings in FY 1976 over FY 1975 (the goal in FY 1976 was level consumption over FY 1975). Again, as in FY 1975, conservation was achieved mainly by restraining demand. Ship steaming hours in FY 1976 were 5 percent lower and aircraft flying hours 6 percent lower than in FY 1975.

In the short-term, the Navy's success in cutting energy consumption will depend on reducing its operational activity. However, according to on-site energy conservation inspection reports, the Navy's shore activities could achieve a greater than 15 percent savings by implementing aggressive conservation programs. This would not affect the

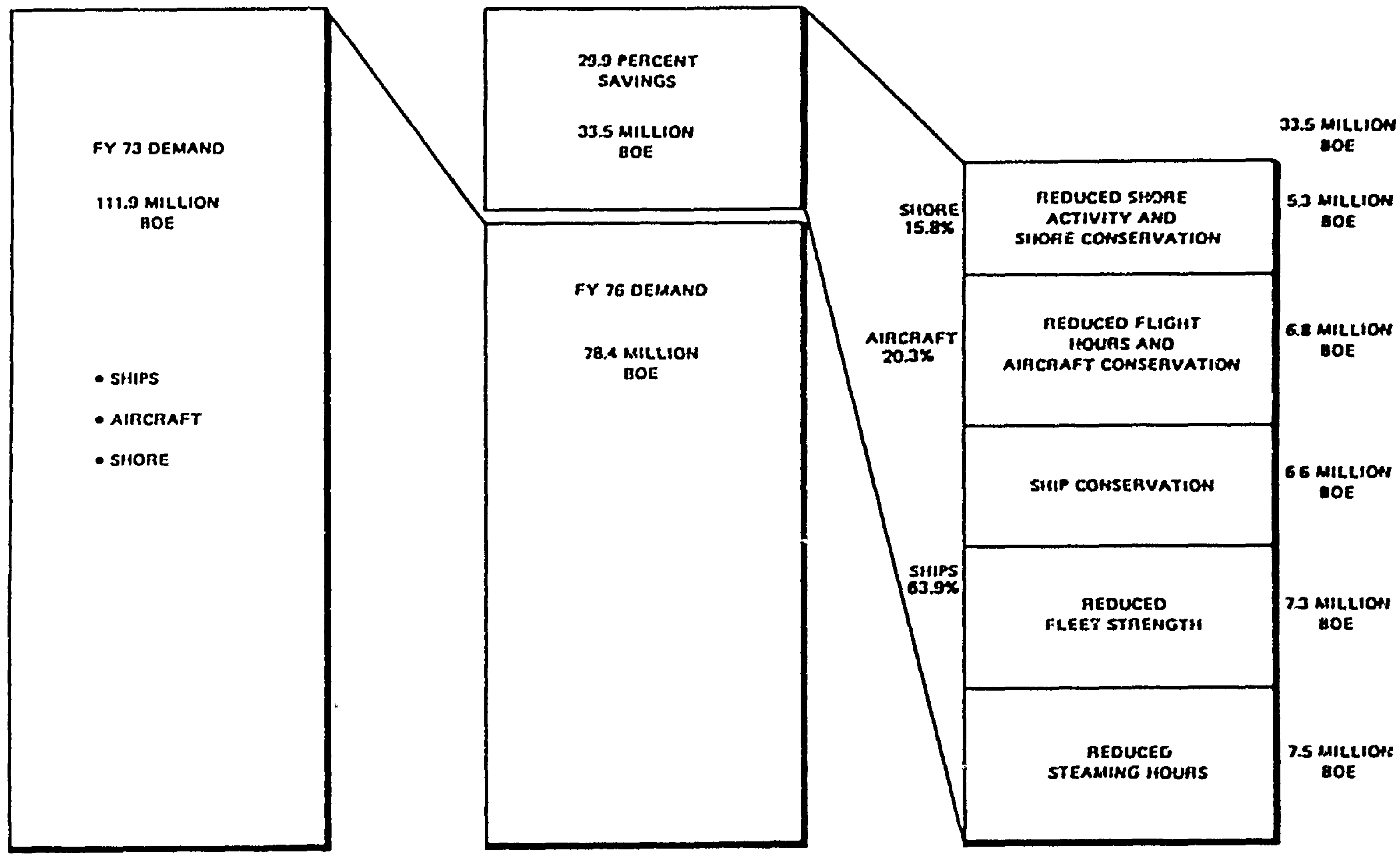


Figure 2. NAVY DIRECT ENERGY CONSERVATION PROFILE, FY 1976
(BARRELS OF OIL EQUIVALENT)

Navy's missions or have a negative impact on morale. It is a question of available man-hours to implement the programs and the command attention that is provided.

The Navy's FY 1975 energy costs were $1.147 billion and its FY 1976 costs were about $1.1 billion. Aggressive energy research and development and facilities engineering programs are under way, but payback for these programs will accrue gradually and will not be significant until between 1980 and 1982.

Since February 1976, the Navy has adopted a more integrated approach to the energy problem and has assigned a mission sponsor to administer dollar resources programs. Formulating energy budgets and determining their relationship to operational requirements (OPTEMPO) are still fragmented and under review.

In FY 1976, 53 percent of the Navy's petroleum was purchased in the Continental United States (CONUS), with the remainder procured from overseas suppliers. Thus, energy costs closely follow world market prices.

Presently, the Navy's fuel policy is to establish one fuel for ship propulsion systems diesel fuel marine (DFM), and to stock two fuels (JP-5 and aviation gasoline) for aircraft. Also, the Navy procures anti-icing additives as part of fuel specification for all purchases of JP-5, at an increased cost of over $2.5 million annually. However, only one aircraft, the S-3A uses this additive, and the need for anti-icing additives is being reevaluated.

The Navy's petroleum, oil, and lubricants (POL) logistics system (terminals, personnel training, etc.) is being extensively modernized. The Navy has adequate total POL storage, given existing requirements, but the storage location is, in some cases, malpositioned for operational needs.

The Navy has four shore bases (Naval Air Station (NAS) Lemore; Naval Weapons Station (NWS) at Seal Beach; Pacific Missile Range (PMR) at Pt. Mugu; and the Naval Shipyard (NSY) at Mare Island) that rely solely on natural gas. Funding has been requested to provide alternative fuels at these bases, and design modifications are under way.

FUTURE ENERGY REQUIREMENTS IN THE DEPARTMENT OF THE NAVY

The Navy's future energy needs are based on the assumption that: liquid hydrocarbons will be the primary energy form required by ships and aircraft to 2000, and the level of the Navy's needs must be ensured to achieve and maintain a military capability necessary to fulfill assigned mission requirements.

The present trend toward more rapid depletion of U.S. petroleum reserves, as compared with world petroleum reserves, and iincreasing reliance on imported petroleum will continue. U.S. government action will probably keep the import ratio of total consumption from rising, for strategic reascns, much above 50 percent; but a lower ratio will probably not be sought for economic reasons. With the increased import level to offset domestic consumption, ample stocks will be available to the Navy through 1985. Beyond 1985, the Navy may face spot shortages of fuels that will affect its operational capability. The Navy must be prepared to operate on synthetic petroleum fuels.

The continual depletion of domestic and global natural petroleum reserves will gradually increase world tensions. Thus, the Navy's best assessment for future energy requirements, using fleet and shore command input, is that the present level of operational activity will increase.

Figure 3 shows the Navy's energy needs to 2000. This energy profile is based on projected force levels, OPTEMPO, unit consumption, and the effects of energy conservation.

Because of depleting resources, increasing recovery and transportation costs, and political factors, the Organization of Petroleum Exporting Countries' (OPEC's) oil prices will probably gradually rise (in 1976 dollars). Even with continued price controls, the price of U.S. domestic oil also will increase. Figure 4 is the Navy's projected energy costs to 2000, which are based on scenarios detailed in Appendix C.

Figure 4 shows that, in 1995, when consumption will probably level off, energy costs will range between \$2 billion and \$2.9 billion (constant 1976 dollars). This is an increase of at least 45 percent over 1976. Case Five, the Navy's best assessment, estimates that the cost of energy will be \$2.46 billion in 1995 and \$3 billion in 2000. The Navy (and the nation) will remain highly vulnerable to oil embargoes and interdiction of oil supply routes throughout this period.

Although the Navy's energy bill in FY 1976 was less than 20 percent of operations and maintenance dollars, this percentage will increase over 40 percent (in constant FY 1976 dollars) in FY 1985. The result of such high energy costs will require that either Congress increase operations and maintenance funding or the Navy will have to reallocate funds among its assigned activities.

THE NAVY ENERGY PLAN: NEW INITIATIVES

The Navy's energy plan gives an integrated energy planning approach, based on the Navy's established energy goals and objectives. These energy goals include reducing the Navy's dependence on foreign energy supplies, and minimizing the penalties imposed on the Navy's operations by increased fuel prices.

In retrospect, world navies have given the major impetus to each significant development of maritime propulsion technology. From sail, to coal, to steam, to nuclear power, and recently, to the gas turbine, naval initiatives have led the way for commercial application. The threat of nonsecure, nonavailable future natural petroleum supplies (1985 to 1995) dictates that the United States take aggressive first steps to shift to alternative fuels. Consequently, the Navy's energy objectives focus on its ability to initiate the first step and provide leadership in making this shift.

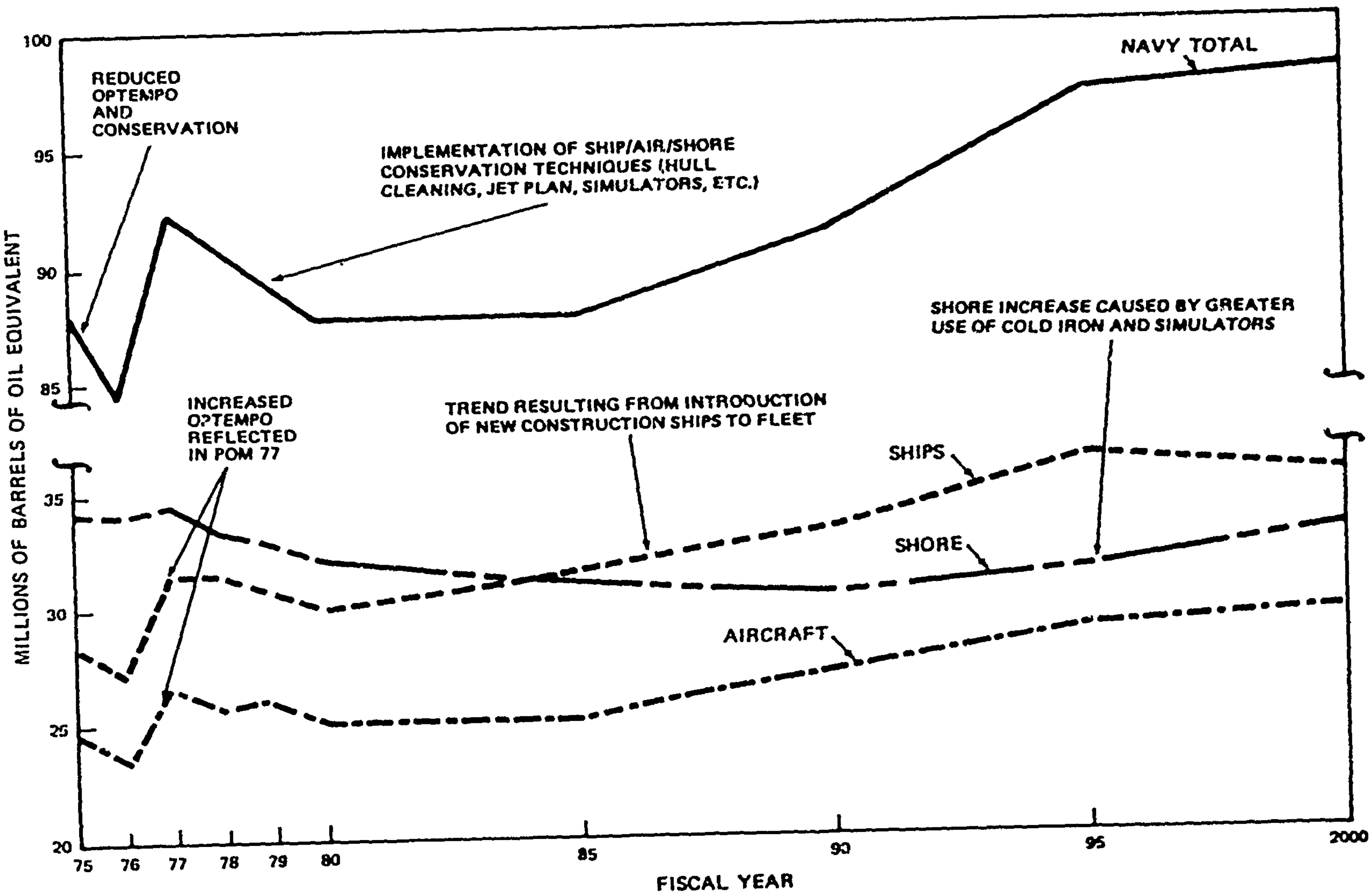
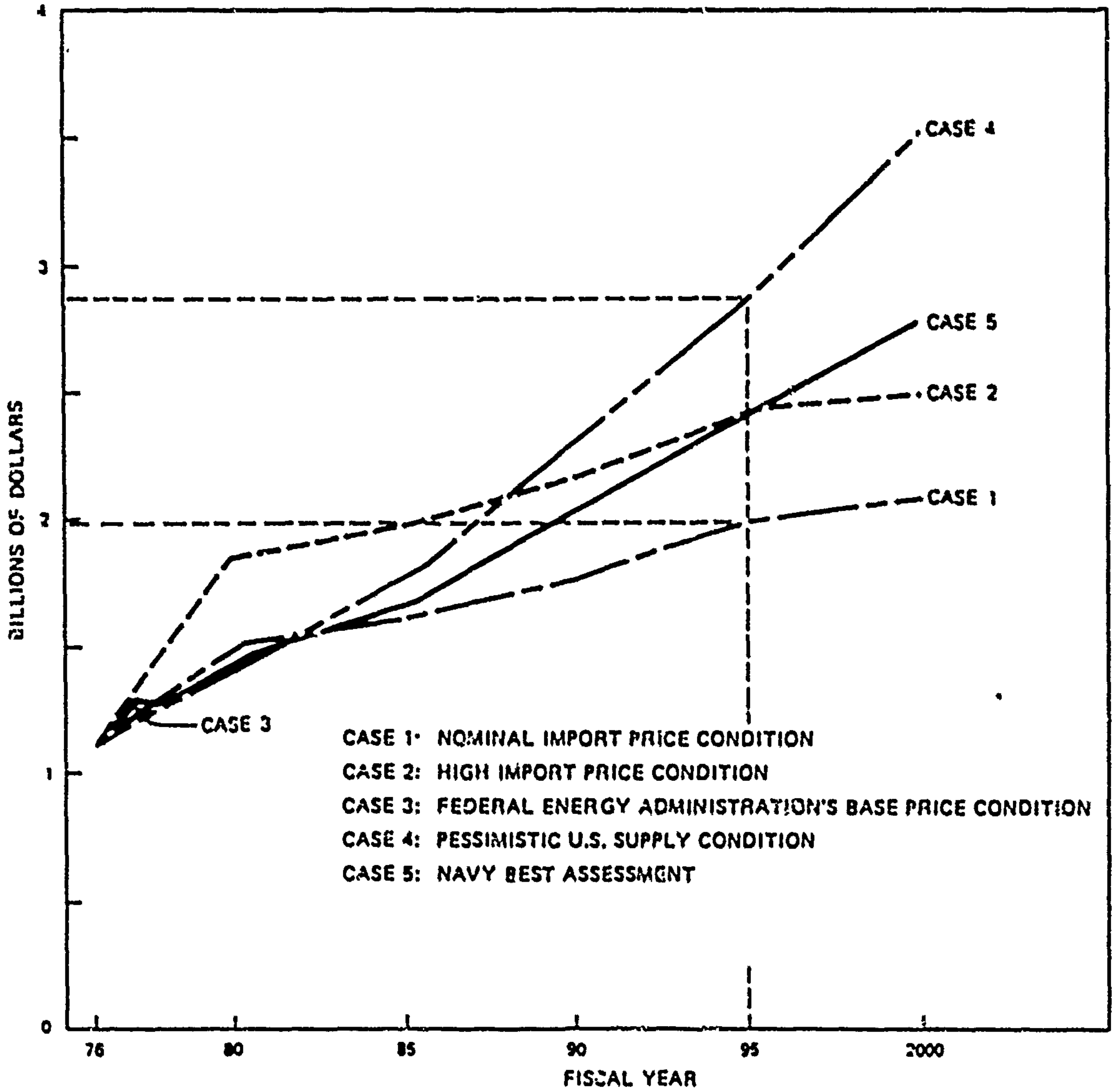


Figure 3. NAVY ENERGY REQUIREMENTS TO 2000



SOURCE: NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976.

Figure 4. NAVY ENERGY FUNDING REQUIREMENTS, 1976-2000 COMPARISON OF CASES (CONSTANT 1976 DOLLARS)

The Navy must be prepared to adjust its methods of doing business, as appropriate, to ensure the shift to synthetic petroleum products after 1985. Thus, we propose that the Department of the Navy: aggressively participate and encourage responsible federal agencies to establish a commercial synthetic fuels industry; and actively acquire and test synthetic fuels to qualify them for the Navy's use. U.S. security is directly related to this effort and, as such, the Navy could play a leading role by establishing itself as an informed customer.

To minimize the penalties of increased fuel prices, the Navy must pursue aggressive research and development and facility engineering projects. The programs described in this plan, and approved by the Navy Energy Office, can have a significant impact by reducing fuel requirements and providing more operational activity for the same Btu expenditure. Examples of new initiatives in potentially high payback energy programs are: improved ship hull maintenance; an enhanced facility energy conservation investment program (ECIP); and increased use of training devices and simulators.

The programs proposed to accomplish direct savings, and, in turn, increase the Navy's operational capability, are shown in Table 1.

Table 1. NAVY ENERGY PROGRAM BUDGET ESTIMATE FY 1977 TO FY 1982 (Millions of dollars)

Energy Research and Development	$158
Naval Facilities (NAVFAC)	
Energy Conservation Investment Program (ECIP)	303
Facilities Energy Engineering	30
Modernization of POL Facilities	49
Cumulative total (FY 1977 to FY 1982)	$540

The estimated $540 million investment represents less than 10 percent of the Navy's energy costs during a DOD prescribed six-year payback period.

The Navy's energy plan, after reviewing the impact of all the Navy's energy programs and increased OPTEMPO over FY 1976, can be initiated with projected energy savings from shore commands because of quick payback ECIP programs. With effective planning and implementation, the Navy will not have to cut back on operational activity but may, instead, increase activity. After 10 years, consumption should level off, if all planned programs (which are 90 percent funded), are executed.

The Navy needs to continually review its fuel storage requirements, based on the changing energy situation. Advance planning for the transition to synthetic fuels should be initiated.

1.0 BACKGROUND: WORLD, U.S., DOD, AND NAVY ENERGY SITUATION

1.1 INTRODUCTION

In October 1973, the world suddenly became aware of the harsh realities of energy supply and demand. Within weeks after the embargo, rising gasoline prices and higher electric bills were destined to become a future way of life. Later, the importance of oil as an essential industrial, commercial, and residential commodity was recognized when the United States and the rest of the industrialized free world fell into a deep recession with high levels of unemployment.

Ironically, although the true value of energy and the consequences of its absence have been clearly demonstrated, the United States has failed to take any meaningful steps to prevent another supply interruption. In fact, as the United States emerges from its recession, it becomes more vulnerable to actions initiated by energy producing nations than any other time in the nation's history. During one week in March 1976, the United States, for the first time, imported more oil than it produced.

It is not surprising that a coordinated national energy plan has not been formulated. Solutions are possible, but there are many extremely complicated and far-reaching issues involving economic growth, employment, standards of living, and the environment. All solutions are costly.

The uncertainty of future oil discoveries, the survival of OPEC, and the achievement of technological advances make decisions on courses of action logically and politically difficult, since successes in one area may obviate the need in other areas. Yet, some plan of action is necessary. Another oil embargo, if sustained for an extended period without significant imports from countries not fully cooperating in the embargo, as experienced in 1973, could have serious international consequences.

This chapter delineates the magnitude of the world, U.S., and defense energy problems and examines the complex issues and limitations involved in achieving energy independence. Also discussed are: the global energy situation; implications of the geological imbalance of energy resources on future energy supplies; domestic resource estimates and production, consumption, and import patterns; and the impact of these trends on the United States and on the Navy in the near-, mid-, and far-terms.

1.2 WORLD ENERGY SITUATION

The global energy crisis is a direct result of the imbalance of the geological distribution of the world's energy resources. This imbalance has near- and far-term implications. Today and in the future, a growing strategic energy dependency among producing and consuming nations will threaten secure and adequate energy supplies. In the long-term, the world must recognize that primary nonrenewable energy resources are being depleted and there must inevitably be a transition to alternative energy sources.

In the last three decades, oil has been the major energy source of most of the industrialized nations. Because of oil's chemical and physical properties, it presents distinct advantages, and, therefore, oil constitutes about 44 percent of the world's primary energy consumption. This is nearly as much as natural gas and coal combined (Figure 1-1). Thus, world energy problems for the industrialized nations are basically oil problems. These problems have resulted because principal oil consumers are not the major oil producers, and world oil supplies are almost exhausted.

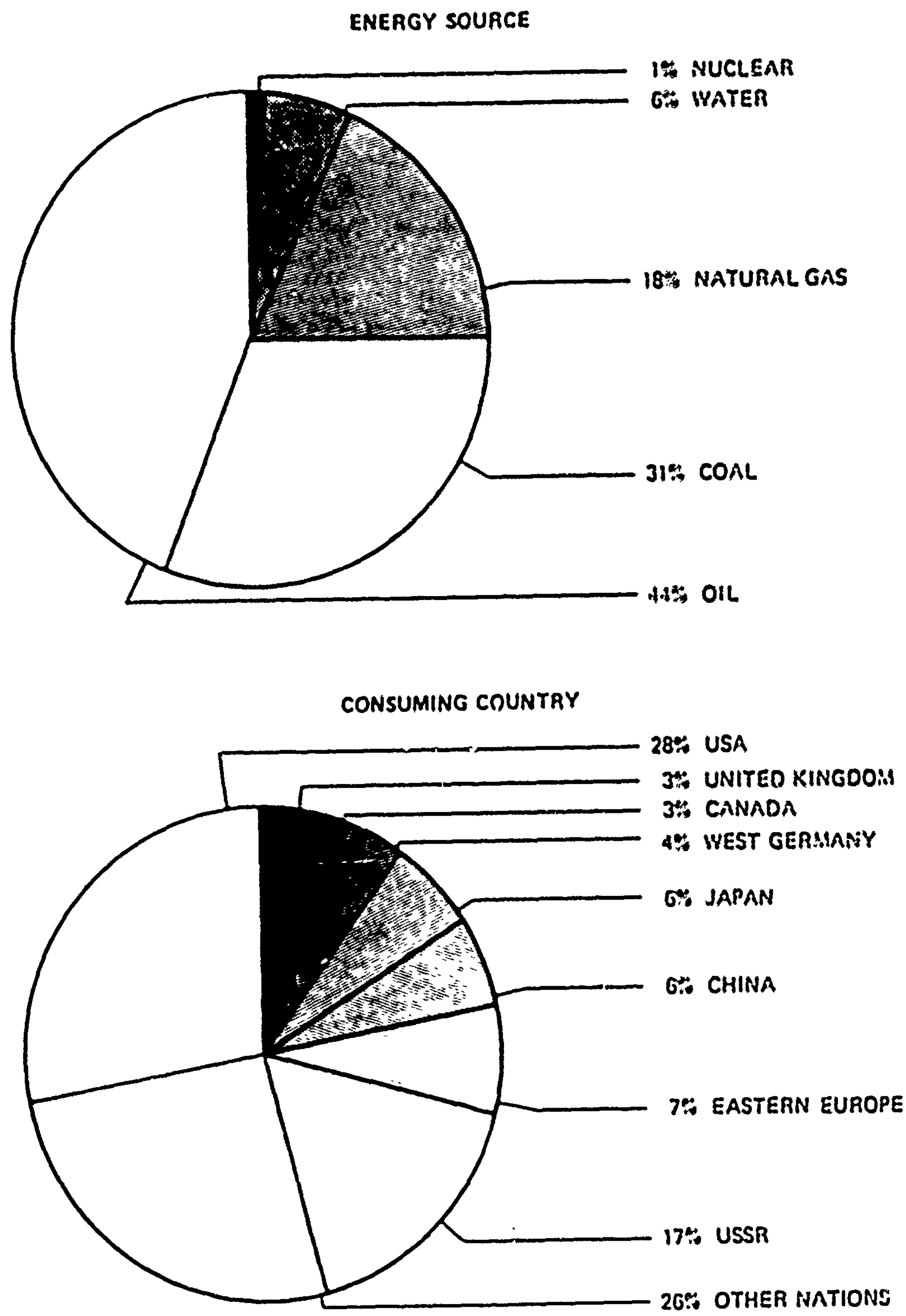
1.2.1 Strategic Oil Dependencies

Figure 1-2 shows the major oil consumers and producers. Although the highly industrialized nations are the heavy users, it is the third world nations that are the predominant producers. The Middle East and Africa account for nearly 50 percent of total world oil production. This imbalance places the oil dependent nations of Western Europe and Japan in precarious positions. The United States was relying on foreign sources for almost 36 percent of its crude oil supplies before the embargo. Although it did not heavily depend on the Organization of Arab Petroleum Exporting Countries' (OAPEC's) crude, the United States did feel the repercussions of OAPEC's sudden withdrawal of supplies.

Today, imports account for 41 percent of consumption. Implications of another possible OAPEC embargo would be extensive, since the U.S. dependency on OAPEC has increased from 31 percent to 43 percent of total U.S. crude imports.

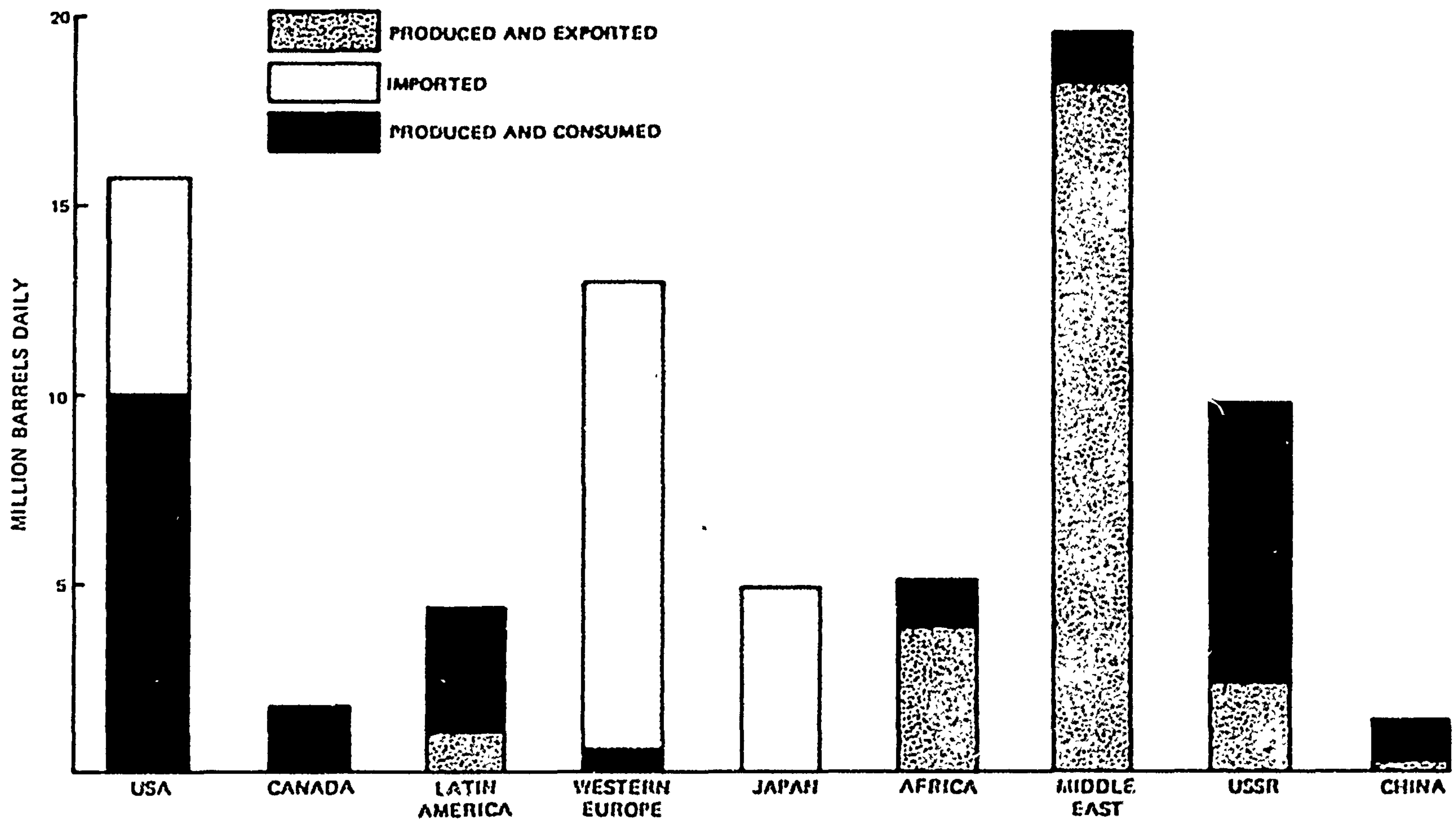
Today, the West continues to be extremely vulnerable to actions taken by other countries to interrupt oil supplies. Since it takes seven years to produce and market oil from new wells, little can be done to reduce U.S. dependence on foreign oil in the near-term, other than to reduce oil consumption. By contrast, the USSR is in a position to become self-sufficient.

The world's geographical distribution of proved crude oil reserves are likely to further polarize producing and consuming nations in the mid- and far-term. Figure 1-3 depicts the geological imbalance. Although more than one-half of the world's proved crude oil reserves—those which have been discovered, measured, and are ultimately recoverable—are in the Middle East and Africa, less than 10 percent are in the United States, Canada, and Western Europe. New discoveries in the West such as the recent finds in Mexico, Norway, and the United Kingdom may temporarily alleviate international oil dependency, but ultimate Western reliance on Middle East and African oil is inevitable unless alternatives are adopted.



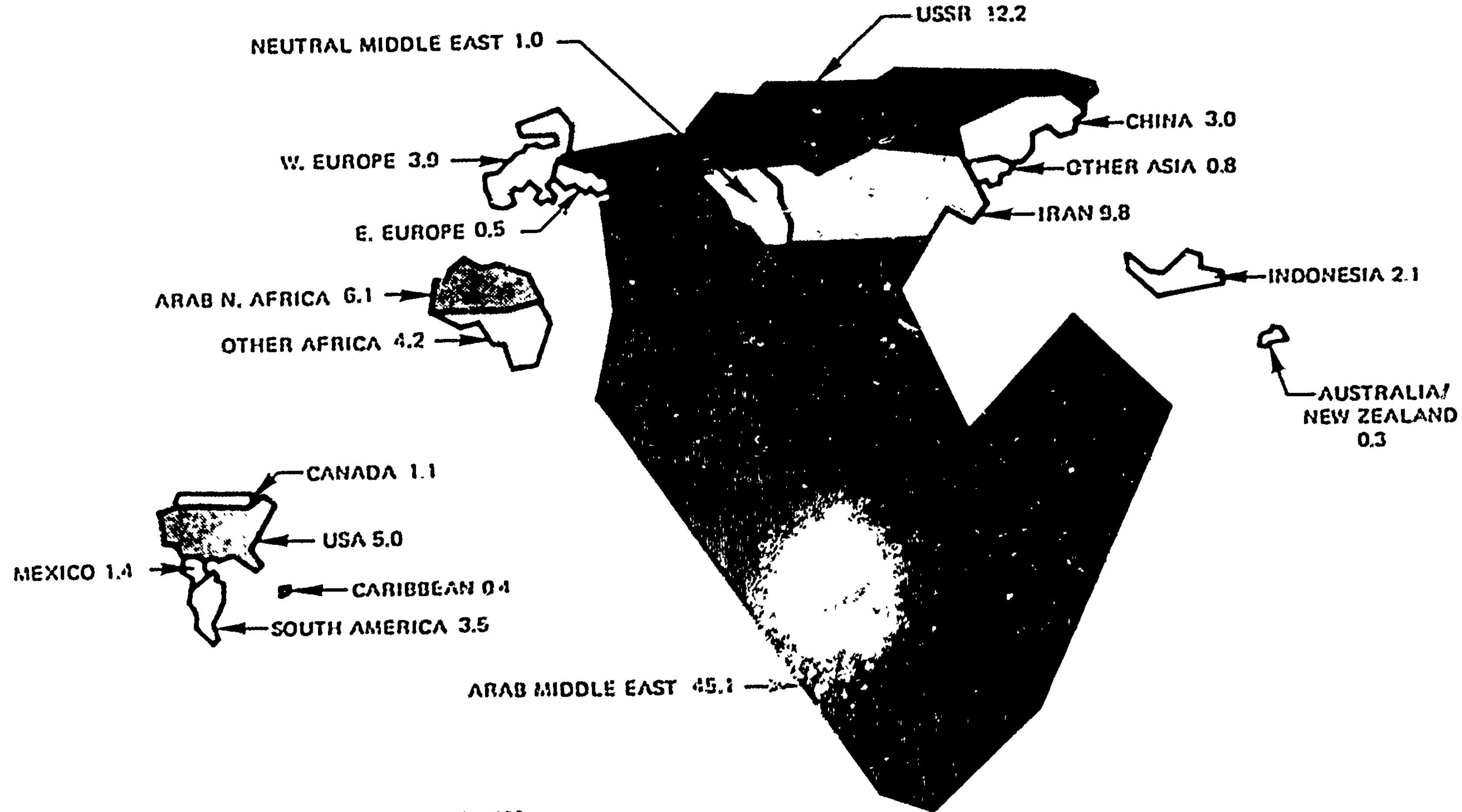
SOURCE: BRITISH PETROLEUM STATISTICAL REVIEW OF THE OIL INDUSTRY, 1975.

Figure 1-1. WORLD ENERGY CONSUMPTION, 1974



SOURCE BRITISH PETROLEUM STATISTICAL REVIEW OF THE WORLD OIL INDUSTRY, 1975.

Figure 1-2. OIL PRODUCTION, CONSUMPTION, AND TRADE (JANUARY 1975)



SOURCE *OIL AND GAS JOURNAL*, SEPTEMBER 27, 1976.
TOTAL ESTIMATED AT 658.7 BILLION BARRELS
SOURCE *OIL AND GAS JOURNAL*, DECEMBER 29, 1975.

Figure 1-3. WORLD PROVED RESERVES OF CRUDE OIL (PERCENT)

1.2.2 World Oil Depletion

The world is rapidly approaching the end of the oil era as we know it today. The transition to alternative energy sources may be necessary before the end of this century.

Estimates show that the world crude oil production will probably peak about 1990. The impact of these projections on world geopolitical stability, although not calculable, could cause major shifts in the world balance of power. Subsequently, the industrial and agricultural nations will feel the impact.

Estimates of world oil wealth depend on: economic and technical feasibility of extracting oil; methods used to estimate reserves; and the degree of certainty assigned to the estimates. Much of the confusion over estimates of the world's oil resources and reserves has come from using different assumptions when incorporating these three factors into the estimates. As a result, there appear to be at least as many estimates of reserves and resources as there are estimators. Rather than favoring any single estimate, the Navy has examined the implications of a broad range of estimates related to its energy situation.

Theoretical world oil exhaustion dates are calculated for the resource boundaries as a proxy for depletion dates. The ultimate depletion date, which is the time when the available resource is below the amount necessary to maintain current consumption patterns, will be determined by several interrelated and often unquantifiable factors. Specifically, the depletion dates, or transition periods, are determined by world oil production, consumption, and pricing policies and, ultimately, discovered recoverable oil. The exhaustion date is when the cumulative consumption of oil exceeds the total ultimately recoverable reserves. The calculation assumes that sufficient oil is produced and available to meet the demand. In actual practice, production will decline as the reserves are used and delay the actual exhaustion date, creating a supply shortfall (that is, depletion). Calculating theoretical exhaustion dates indicates the length of time current production and consumption trends could continue until oil supplies are exhausted.

Three alternative oil consumption growth rates have been used to determine possible exhaustion dates (See Figure 1-4). The conservative 2.5 percent annual consumption growth rate projects that between 2015 and 2025 the entire estimated range of recoverable resources will be exhausted. If an historical growth rate of 7 percent is assumed, exhaustion will occur sometime between 2000 and 2005. In the unrealistic, but most optimistic case of no increase in consumption, exhaustion will occur no later than 2070.

The proximity of the exhaustion date for the historical growth rate and the relative insignificance of the actual reserve estimate, except under the no-growth case, are significant. The low growth alternative could stretch available recoverable oil by about 25 years.

Theoretical exhaustion dates for world areas will vary significantly because of the location of oil bearing formations, local production and consumption patterns, and different trade policies. Figure 1-5 gives the exhaustion dates for world regions, assuming

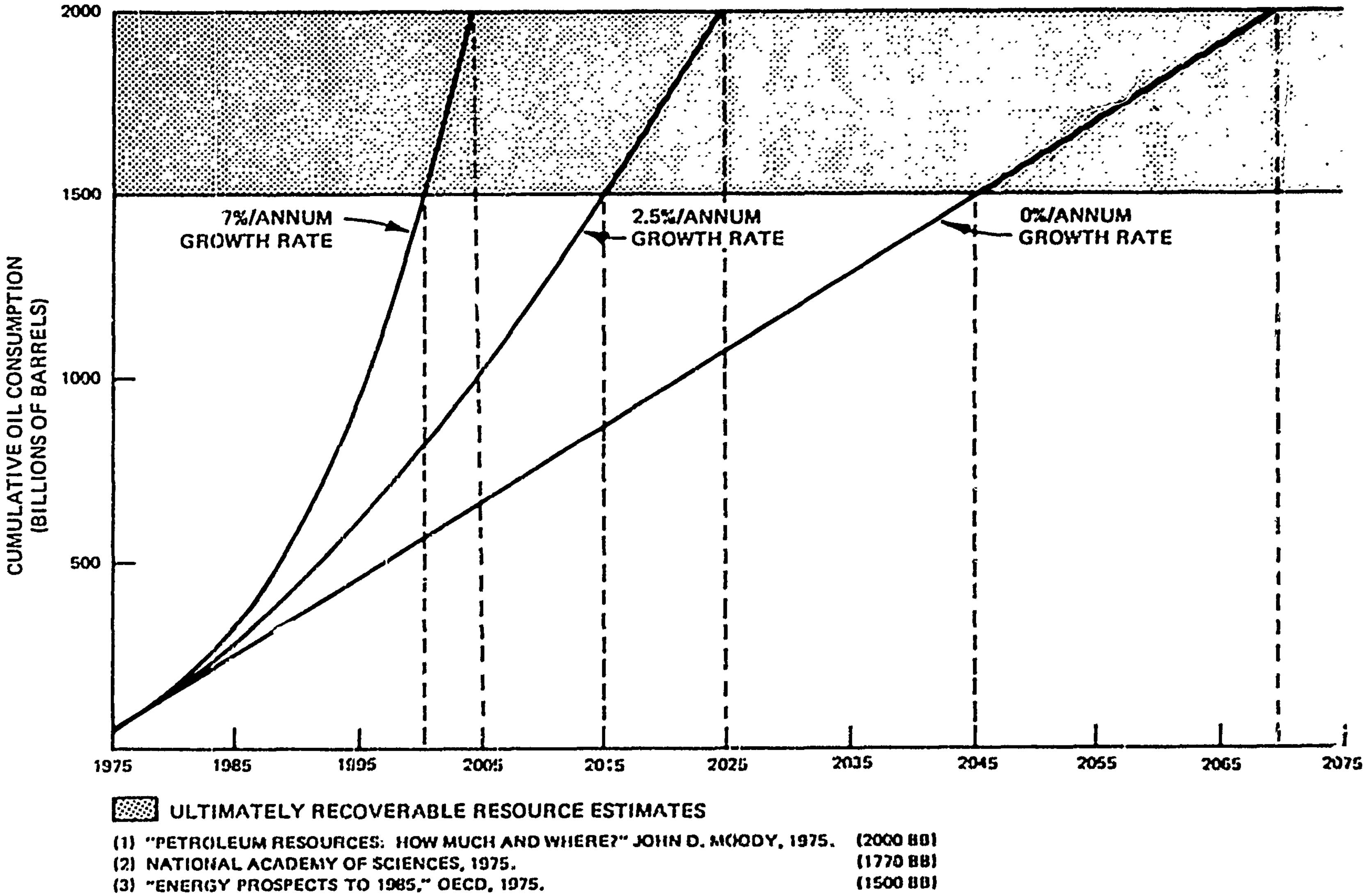
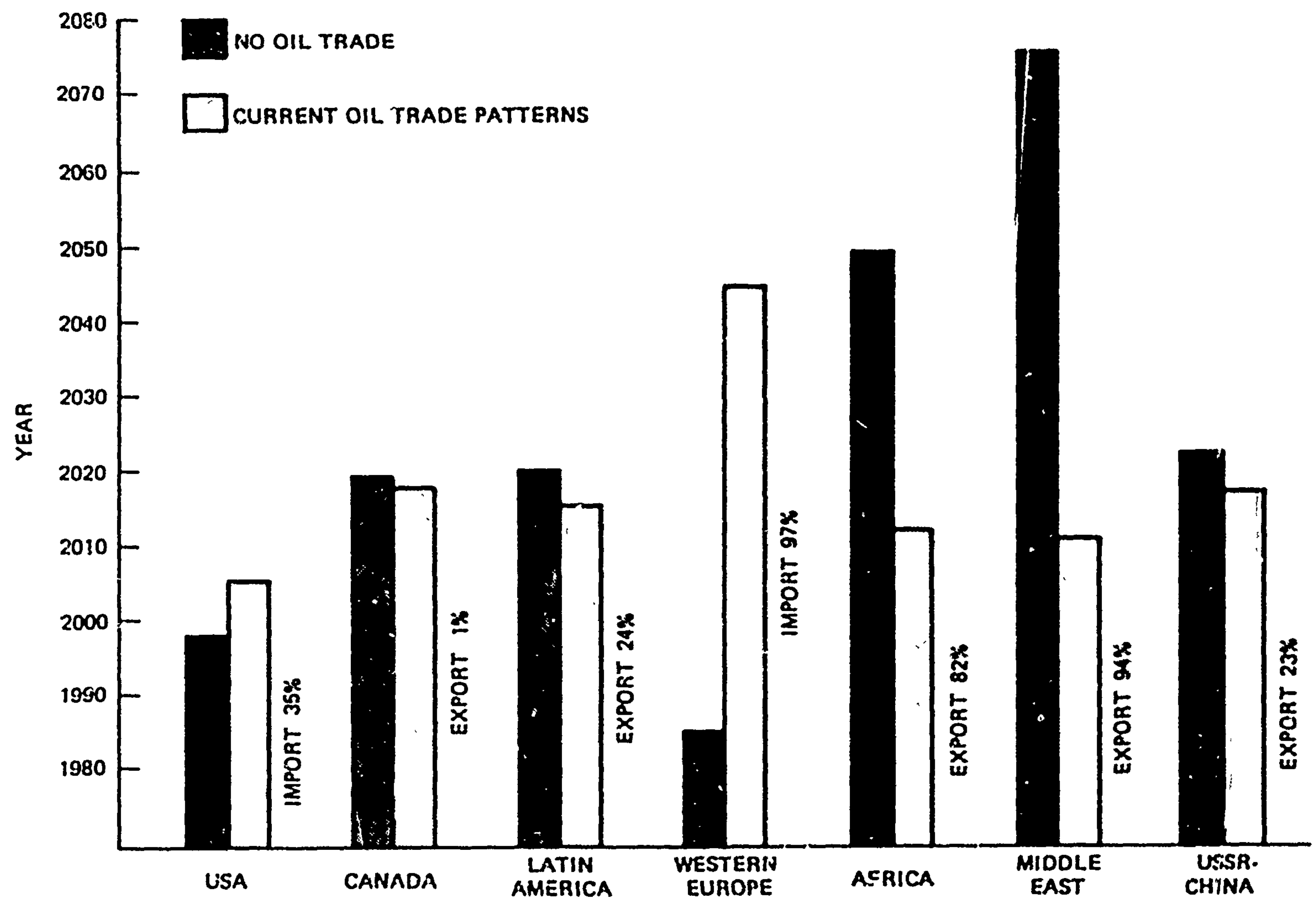


Figure 1-4. WORLD OIL EXHAUSTION



*ASSUMES 4 PERCENT ANNUAL GROWTH IN OIL CONSUMPTION AND JOHN D. MOODY'S PETROLEUM RESOURCE ESTIMATES.

Figure 1-5. REGIONAL OIL EXHAUSTION DATES* oil consumption will have an average annual increase of 4 percent and there is no oil trade. The proximity of Western Europe's exhaustion date relates directly to its heavy dependence on foreign oil sources. Likewise, the United States is destined to face greater dependence on oil imports as its oil resources are depleted. The Soviet Union, on the other hand, has at least 20 more years of available oil than does the United States.

Many countries are extending their exhaustion date by substituting foreign oil for domestic oil. Figure 1-5 also depicts the exhaustion dates of these regions' domestic supplies when current import patterns are projected for the future. Thus, to extend available domestic oil resources, many countries, in choosing an alternative, will still depend on foreign oil. Since Western Europe relies heavily on foreign sources, its exhaustion date can be postponed to about 2040, but this region will still substantially rely on foreign sources. For the United States, heavy dependence on oil imports will only delay the exhaustion date by about six years.

1.2.3 Alternative Sources for Oil

Dwindling sources of conventional crude oil deposits can be supplemented with oil extracted from oil shale and bituminous tar sands. Both contain large amounts of potentially recoverable oil. Figures 1-6 and 1-7 show the geographical distribution of these resources. The World Energy Conference estimates that these deposits would more than double the amount of crude oil that could ultimately be recovered. Today, the extraction cost from these deposits cannot compete with the cost of crude from conventional oil wells. However, as crude oil supplies from traditional sources decrease and crude oil prices increase, the alternative sources will be tapped.

Crude oil and oil product supplies can also be augmented through conversion of coal and other fuels. First-generation commercial coal liquefaction plants are successfully operating in South Africa. Demonstration scale tests, which are just beginning in the United States, are being used to develop economical second-generation conversion processes. For the United States, with its vast coal reserves and its diminishing crude oil supply, this technology could be vital in achieving energy independence.

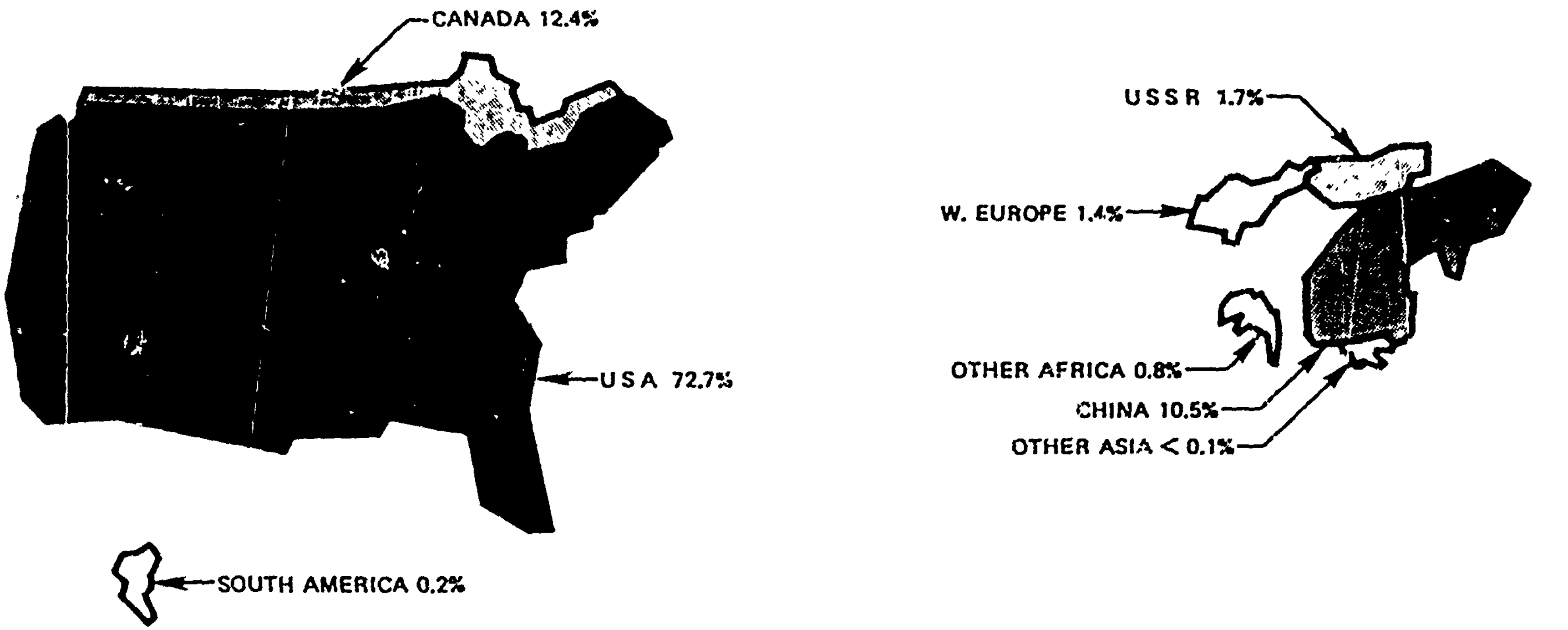
1.2.4 Substituting Alternative Fossil Energy Sources

Natural Gas Resources

The natural gas situation is similar to the oil situation. As natural gas is usually found near oil-bearing formations, the world distribution of proved gas reserves resembles the distribution of oil reserves; however, this excludes significant formations in the Soviet Union (see Figure 1-8). Large gas imports are a practical substitute for domestic sources only when they are transported by pipeline. This is because shipping by tanker requires extensive special handling to liquefy and regasify the product. As a result, natural gas imports will supplement rather than substitute for dwindling domestic energy sources.

Ultimately recoverable natural gas resource estimates, based on current technological and economic conditions, vary as much as oil resource estimates. Figure 1-9 shows

TOTAL ESTIMATED AT 1,462.5 BILLION BARRELS



SOURCE: 1974 WORLD ENERGY CONFERENCE.

Figure 1-6. WORLD RECOVERABLE OIL SHALE

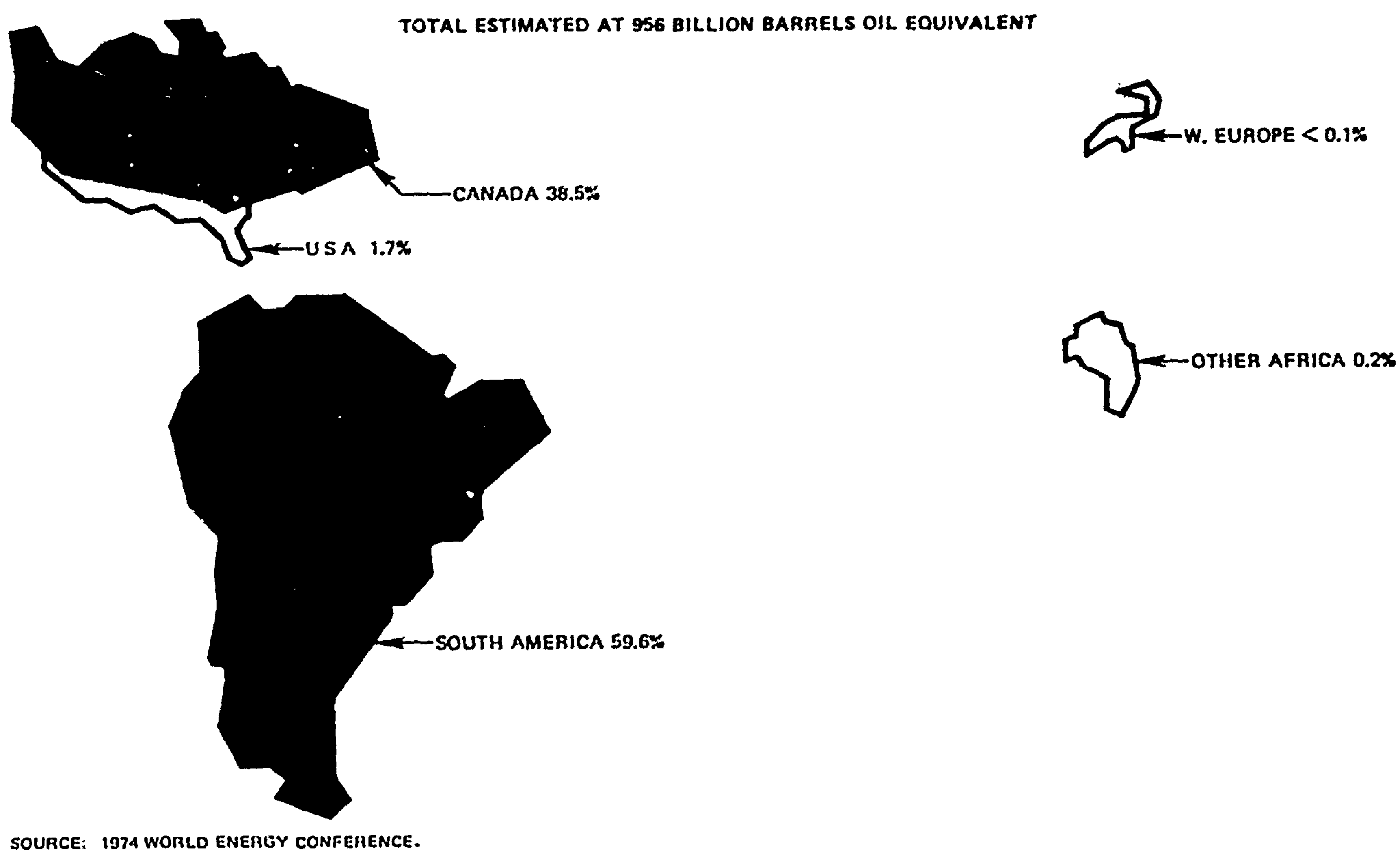
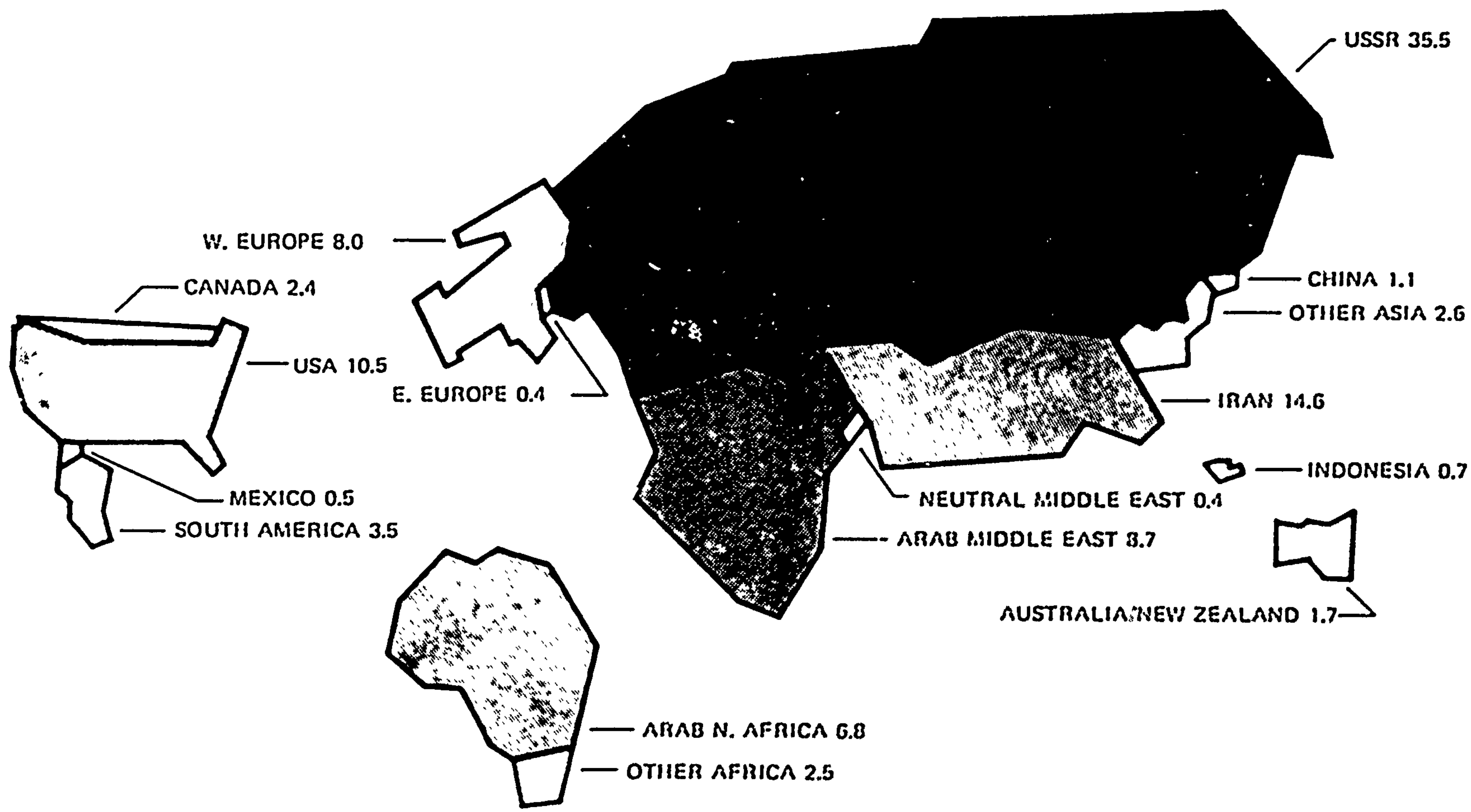


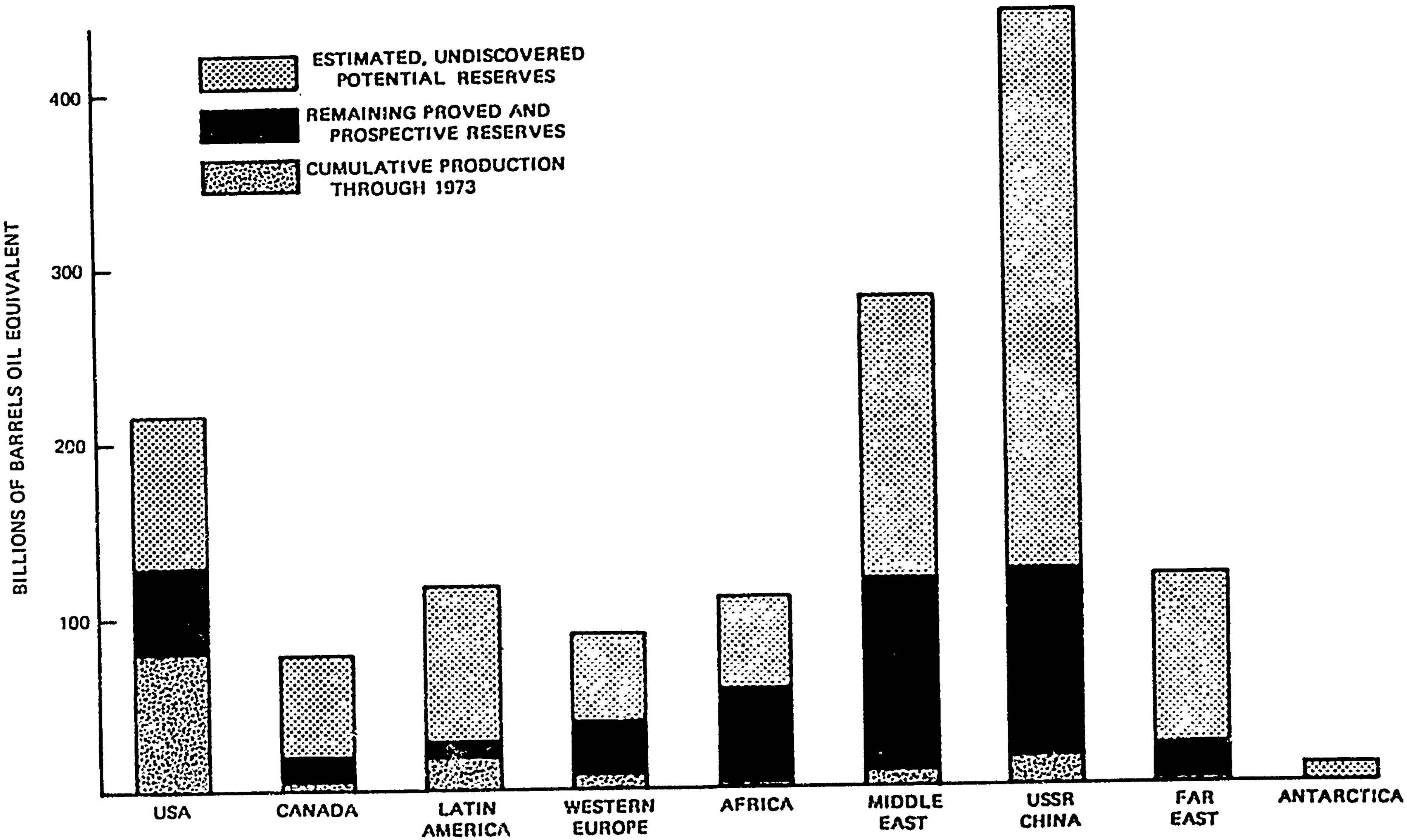
Figure 1-7. WORLD RECOVERABLE TAR SANDS



WORLD AGGREGATE: 400.7 BILLION BARRELS OF OIL EQUIVALENT

SOURCE. *OIL AND GAS JOURNAL*, DECEMBER 29, 1975.

Figure 1-8. WORLD PROVED NATURAL GAS RESERVES (PERCENT)



SOURCE: JOHN D. MOODY, "PETROLEUM RESOURCES: HOW MUCH AND WHERE?," 1975.

Figure 1-9. ULTIMATELY RECOVERABLE NATURAL GAS

estimates, made by John D. Moody, that are significantly higher than other current estimates, although the geographical distribution is typical. Using Moody's estimates and simplifying assumptions as to consumption and production policies, theoretical exhaustion dates were calculated (see Figure 1-10). Two possible consumption and production policies are represented by the upper and lower curves. The upper curve represents current production and consumption patterns and the lower curve represents a low growth pattern where production and consumption are constrained. The results indicate that exhaustion will take place between 2033 and 2075, even assuming Moody's high estimate of available resources. If available resources prove to be only two-thirds of Moody's estimate, then exhaustion will take place between 2022 and 2055. The consumption growth rates have only a minor impact on projected depletion dates. It is noteworthy that the results of this analysis show the decline in natural gas supplies coincides with the decline in oil, as illustrated in Figure 1-4.

Coal Resources

Coal resources constitute over 53 percent of the world's recoverable fossil energy resources. Yet, coal consumption accounted for only 29 percent of world energy consumption in 1974. Figure 1-11 shows proved coal, oil, and natural gas reserves by geographical regions. This figure indicates that although the less developed countries control the world's oil and natural gas resources, the bulk of the world's coal deposits are in the industrialized western nations. The United States has more potential energy output (Btus) in coal reserves than the Middle East has in oil. Also, Europe and the Soviet Union have large coal reserve supplies.

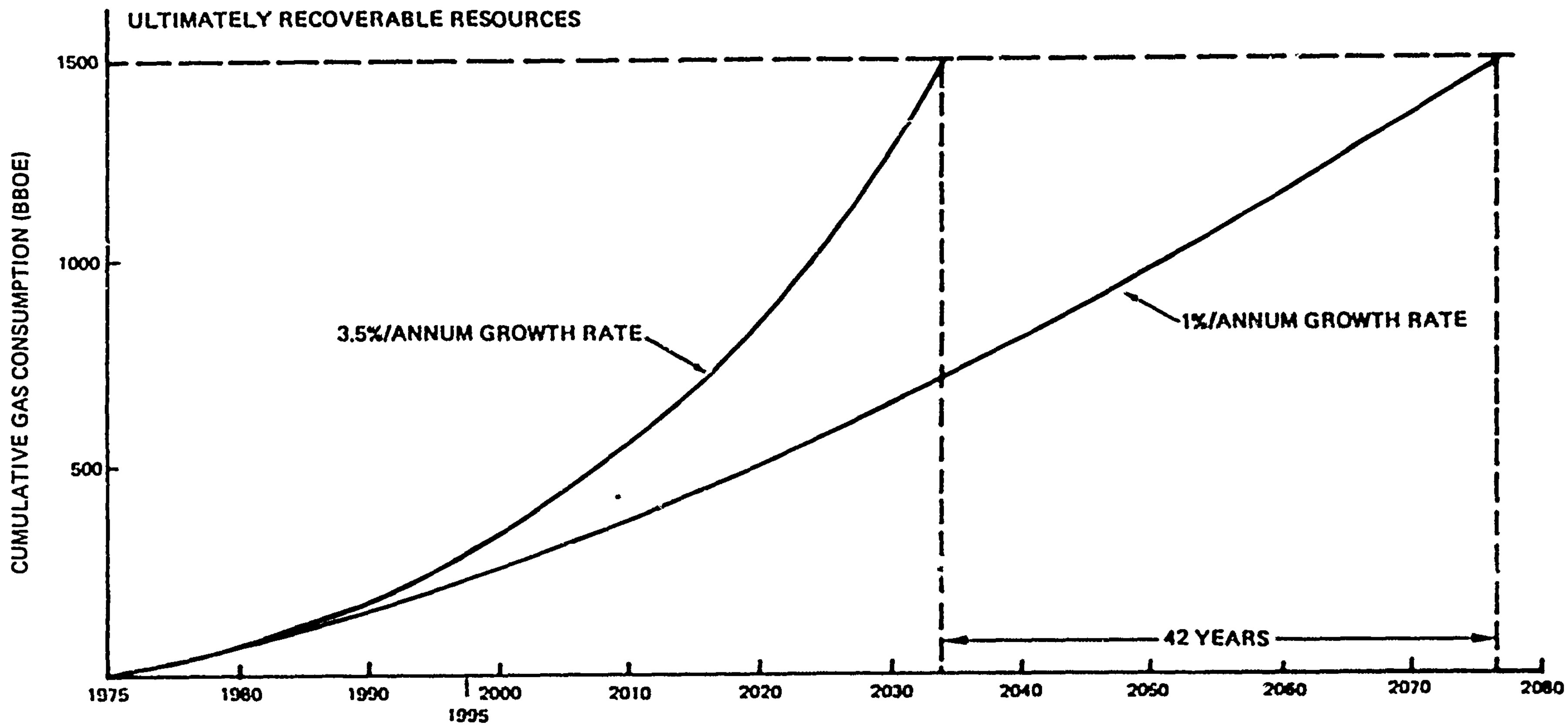
Although rich in coal resources, western industrialized nations have left their coal resources virtually untapped and continue to rely on dwindling supplies of environmentally clean oil and natural gas. Figure 1-12 depicts the primary energy production and consumption profiles in various world areas. Oil is the leading energy source in every area except the communist countries, where coal predominates.

1.3 U.S. ENERGY SITUATION

1.3.1 Current Energy Consumption Patterns

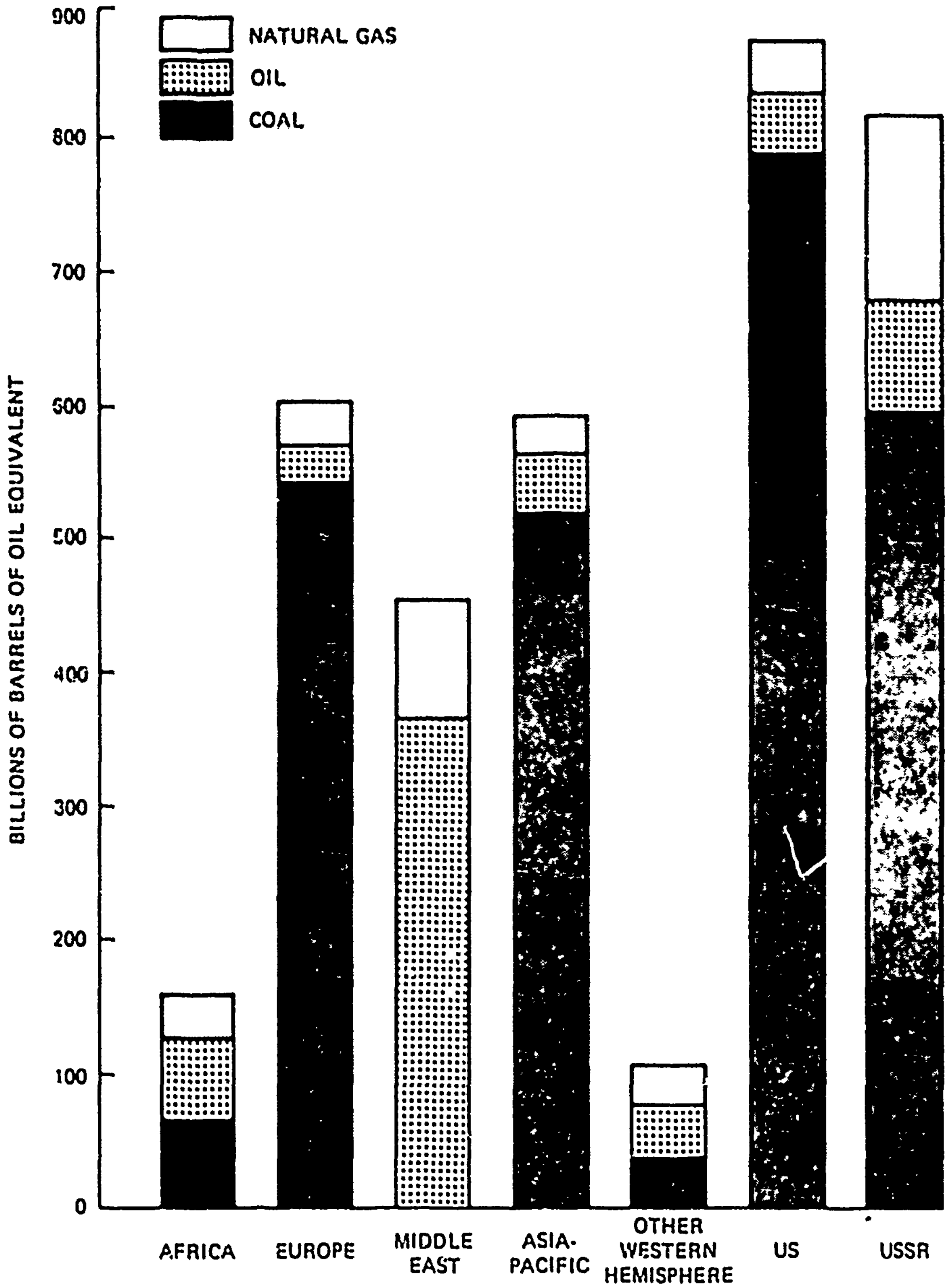
Figure 1-13 shows the basis of the U.S. energy problem. This figure indicates that although the United States has abundant energy resources, it relies on its least available resource. Coal, the largest fossil energy resource, includes 90 percent of proved reserves, but constitutes only 18 percent of U.S. energy consumption; while 82 percent of consumption is from sources that make up only 10 percent of the nation's proved reserves. This imbalance is caused by the valuable properties of oil and natural gas that enable their production, transportation, storage, and use in a way that is cheaper, easier, safer, and cleaner than coal.

Figure 1-14 shows that primary energy sources are introduced and used by the economy via complicated energy patterns. Essentially, all these sources can produce



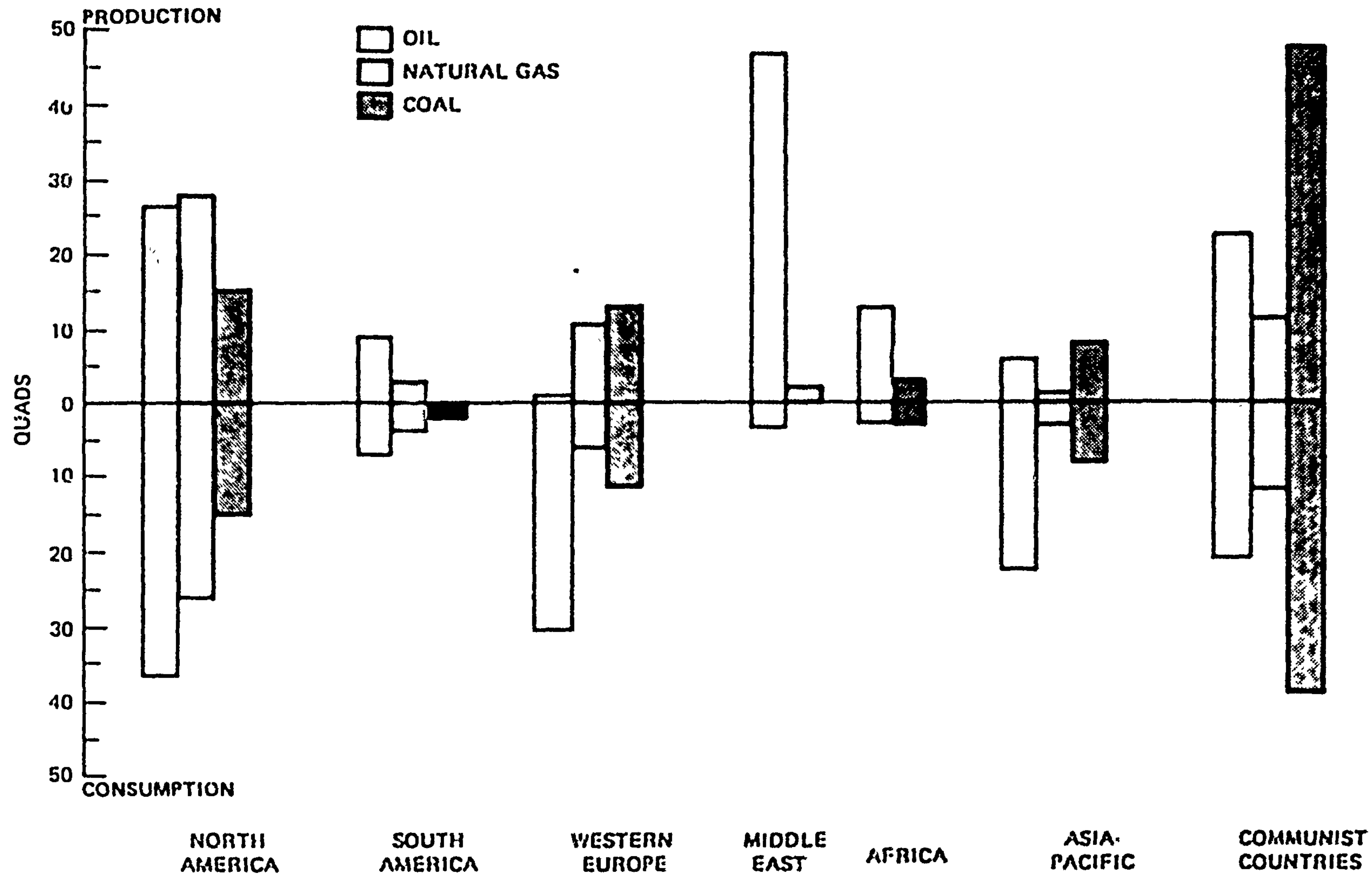
BBOE: BILLIONS OF BARRELS OF OIL EQUIVALENT

Figure 1-10. WORLD NATURAL GAS EXHAUSTION



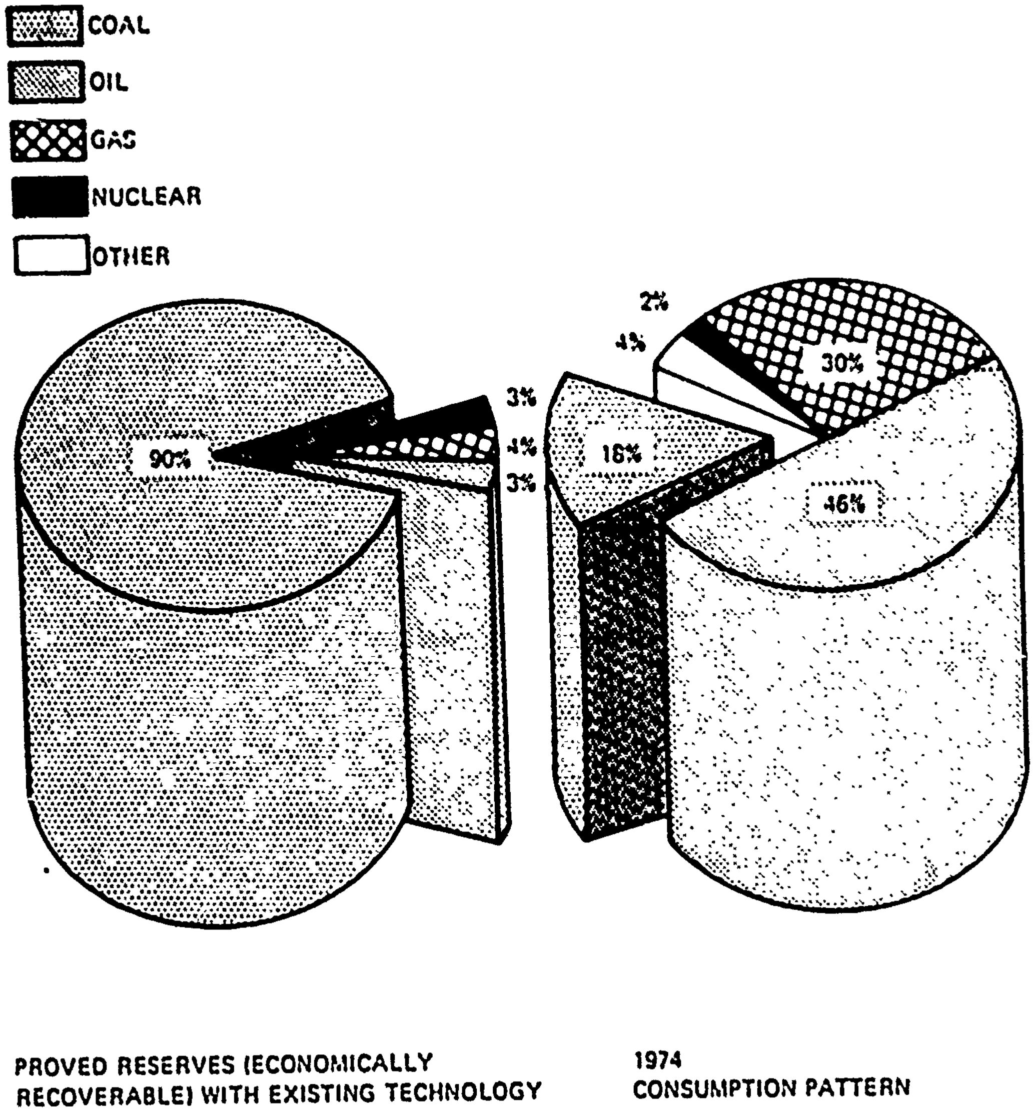
SOURCES: 1974 WORLD ENERGY CONFERENCE, *OIL AND GAS JOURNAL*, DECEMBER 29, 1975.

Figure 1-11. PROVED RESERVES OF COAL, OIL, AND NATURAL GAS BY REGION



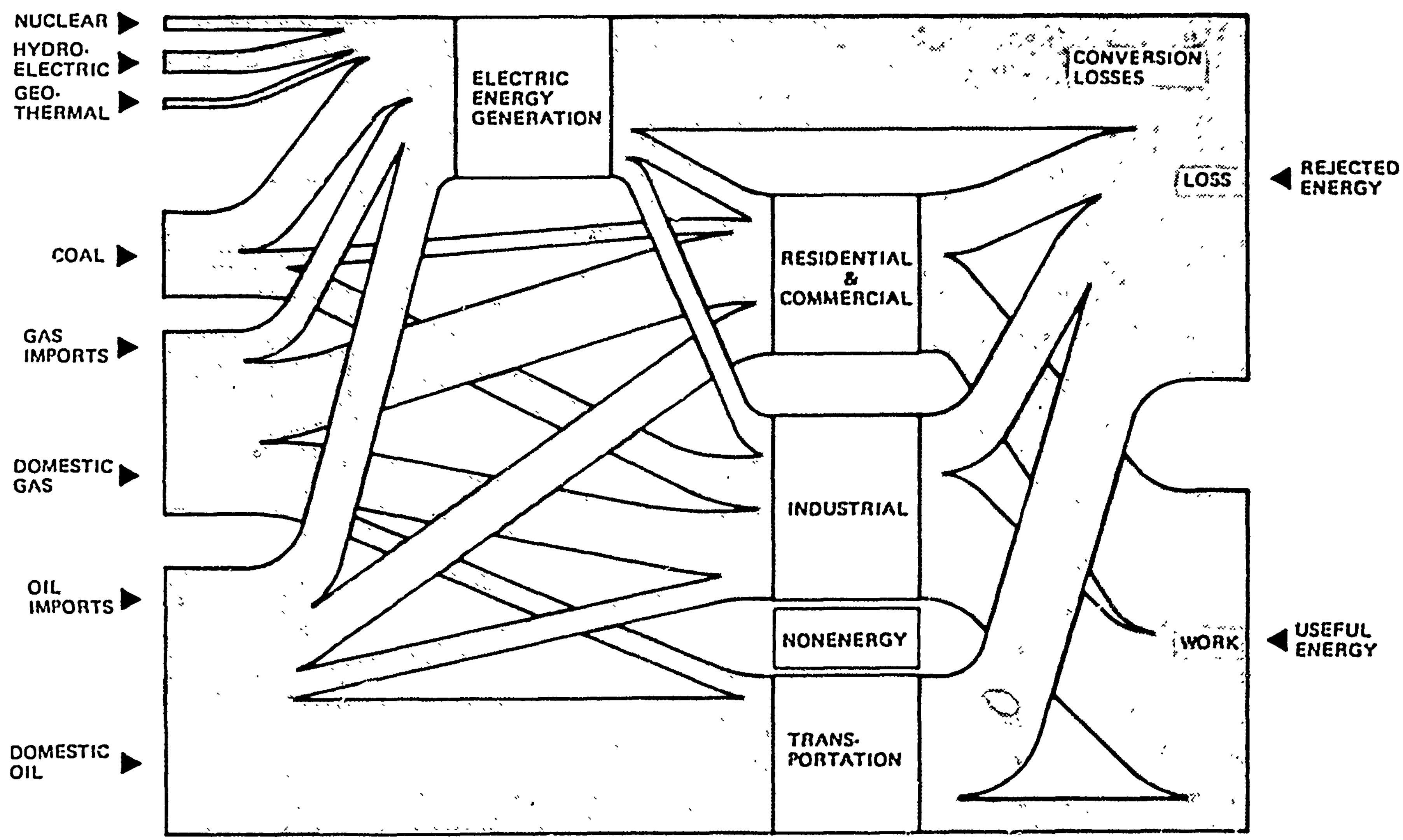
SOURCES: BRITISH PETROLEUM STATISTICAL REVIEW OF THE WORLD OIL INDUSTRY, 1974. INTERNATIONAL COAL TRADE, 1975; INTERNATIONAL PETROLEUM ENCYCLOPEDIA, 1975.

Figure 1-12. ENERGY PRODUCTION AND CONSUMPTION PROFILES, 1974



SOURCE: NATIONAL ENERGY OUTLOOK, FEDERAL ENERGY ADMINISTRATION, 1976.

Figure 1-13. SOURCES OF THE U.S. ENERGY PROBLEM



SOURCE *THE NATIONAL ENERGY DILEMMA* JOINT COMMITTEE ON ATOMIC ENERGY, 1973

Figure 1-14. ENERGY INPUT-OUTPUT PATTERNS, 1980 electricity. However, electricity can be used in nearly all non-transportation markets, and, therefore, it competes directly with the primary sources from which it was generated. Since coal can be used to generate electricity, it is possible to shift the nation's energy consumption from oil and gas to alternative sources without significantly disrupting the economy.

Additionally, it is significant that more energy is lost during energy conversion from one form to another than is ultimately used by the economy.

1.3.2 Oil Resources, Reserves, and Depletion

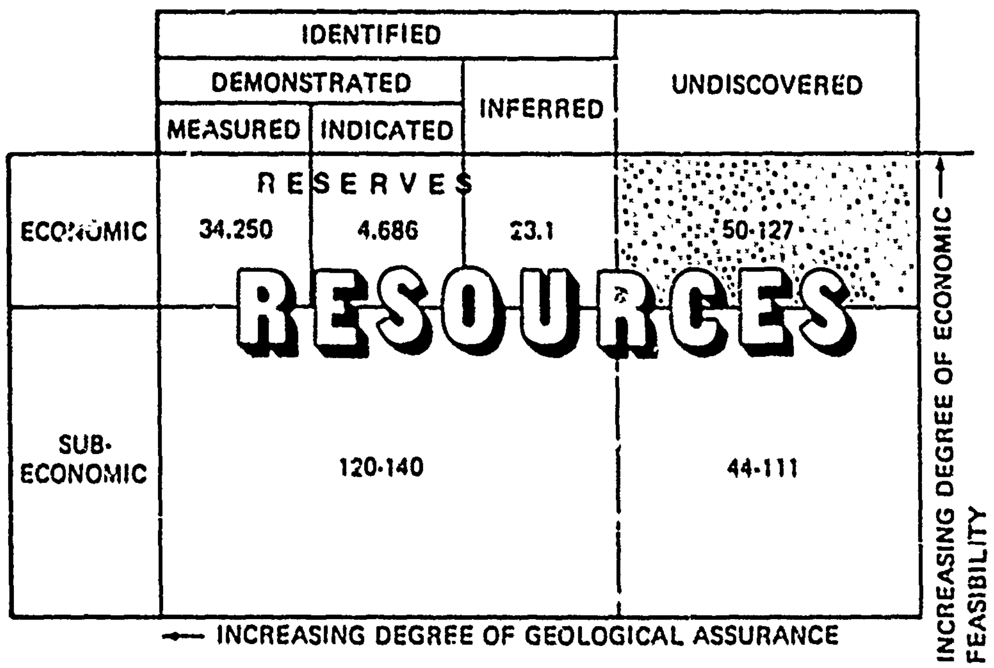
Until recently, cheap available foreign crude oil reduced the demand for costlier domestic sources and precipitated a decline in production of the nation's most vital energy product in the early 1970s. At the close of 1975 and during the first half of 1976, the United States was relying on OPEC nations for about 60 percent of its crude oil and refined petroleum products. Nearly 84 percent of imported crude oil in the first half of 1976 was supplied by the OPEC cartel (over 43 percent from Arab nations), which is a 12 percent increase from just prior to the October 1973 crisis.

Much of the readily recoverable onshore oil in the conterminous United States (lower 48) has already been tapped. If resource estimates made by the USGS are correct, the United States has already consumed more than 32 percent of its original oil. New production will come from increasingly costly, but more effective, secondary and tertiary recovery methods, new areas on the Outer Continental Shelf (OCS), and Alaska.

Reliable U.S. resources and reserves estimates are a major factor in determining future oil and energy policies. Grossly understated reserves would hasten needless rapid development of costly alternative fuels. Historically, estimates of ultimately recoverable oil reserves increased as more promising geological areas were explored. Recently, this trend has been reversed. Estimates of U.S. undiscovered, recoverable oil and gas have been declining since 1965 as areas once thought to be promising have proven disappointing.

Figure 1-15 shows the latest USGS estimates of U.S. oil resources and reserves. Four categories of reserves denote the degree of certainty in the estimate. Measured reserves are "proven," that is, they exist and are economically recoverable. Indicated and inferred reserves possibly exist based on examining present geological formations. Undiscovered economic reserves are postulated oil-bearing formations based on historical extrapolations.

Any estimate involves a large degree of uncertainty. For example, the USGS's best estimate (90 percent confident) is that undiscovered economic oil reserves are between 50 billion and 127 billion barrels. Measured, indicated, and inferred reserves are only 62 billion barrels. Depending on the actual amount ultimately found, undiscovered economic reserves (hypothetical) constitute between 40 and 60 percent of the nation's ultimately recoverable resources. These estimates are based on current technological and economic conditions. As conditions change, the portion of the resource base that is considered discovered reserves will also change. However, it is not anticipated that these changes will increase reserve levels by more than 40 billion barrels, or 20 percent in this century.



TOTAL US CUMULATIVE PRODUCTION: 106 BILLION BARRELS (12/31/74)

SOURCE: FEDERAL ENERGY ADMINISTRATION, OIL AND GAS RESOURCES, RESERVES, AND PRODUCTIVE CAPACITIES, JUNE 1975.

Figure 1-15. U.S. CRUDE OIL RESOURCES AND RESERVES

Theoretical oil exhaustion dates have been calculated for two import profiles. The first import profile assumes the United States will risk being 40 percent dependent on foreign oil sources. In addition, all USGS indicated petroleum resources will be actually discovered, recovered, and production levels achieved. The historical oil consumption growth rate, which annually varied from 3 to 8 percent between 1966 and 1973, will continue. In this profile, the nation's petroleum resources will be exhausted in 30 years. If U.S. policy were to reduce oil consumption growth in half (or about 2 percent), it would delay exhaustion by only three to seven years, depending on the true level of available reserves.

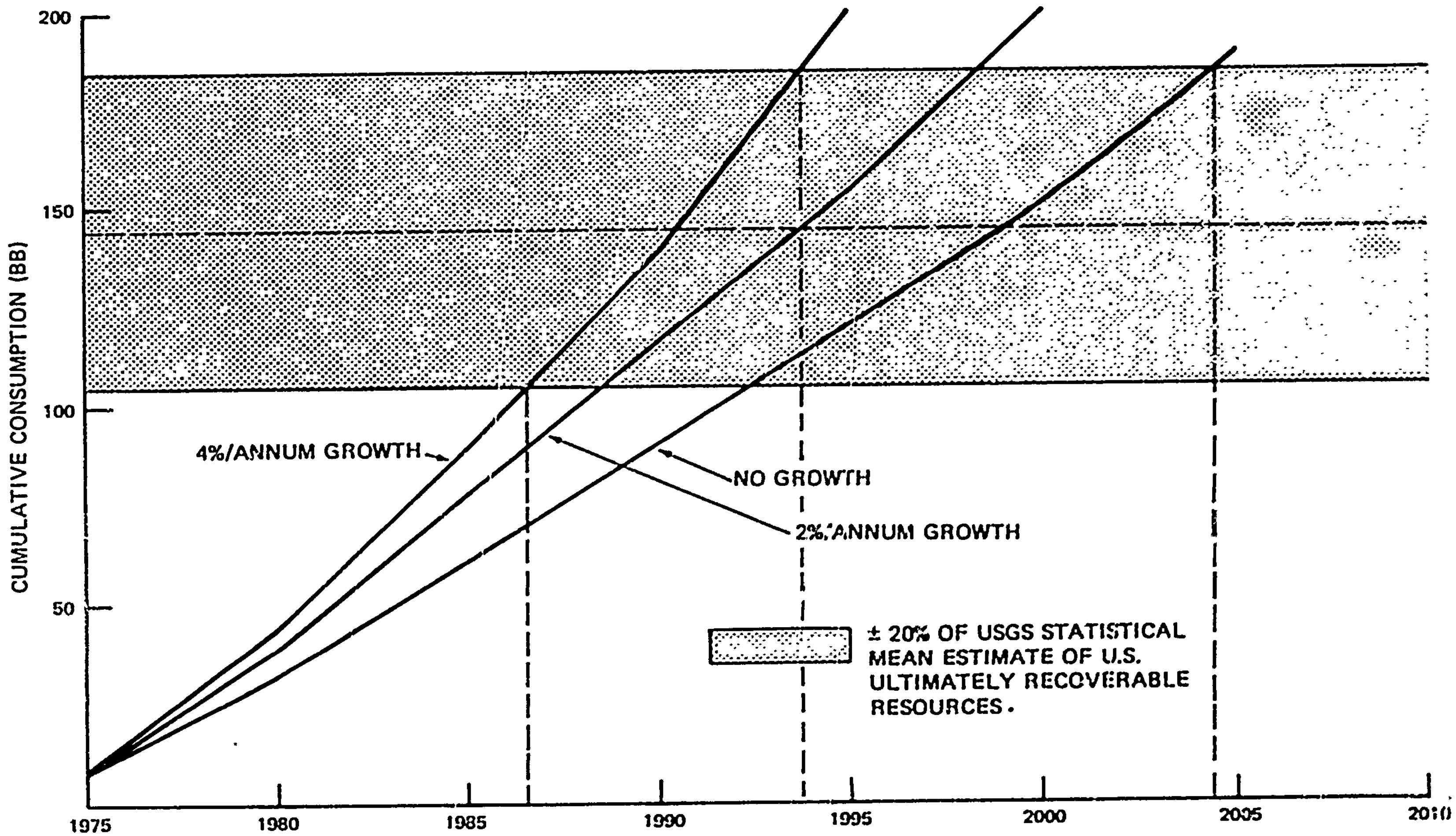
The second import profile assumes that only domestic petroleum sources will supply the nation's needs. However, in both profiles, the estimate of ultimately recoverable resources, being plus or minus 20 percent of the statistical mean of USGS's 1975 estimate, reveals that the exhaustion dates are very close, as illustrated in Figure 1-16. For example, if U.S. production has to meet an annual growth rate of 4 percent, the total recoverable resources would be exhausted between 1987 and 1993, depending on the accuracy of the indicated level of available reserves. Regardless what consumption growth rate is used, exhaustion will occur between 1987 and 2004.

1.3.3 Natural Gas Resources, Reserves, and Depletion

The bulk of the nation's domestic natural gas is found in and along the Gulf of Mexico. There is virtually no production in the Pacific or Atlantic coastal states. However, natural gas reaches all regions of the country through a vast pipeline network. U.S. natural gas production began declining in the early 1970s. Today, the U.S. imports 4 percent of its natural gas by pipeline from Canada.

USGS estimates that ultimately recoverable resources in the United States are between 777 trillion cubic feet (TCF) and 1,161 trillion cubic feet (133.5 to 199.5 BBOE). The uncertainty in estimating postulated recoverable resources (which is 338 TCF to 722 TCF), accounts for the difference in figures. Depending on the actual amount in the ground, recoverable resources are between 45 and 60 percent of ultimately recoverable resources.

The estimates and projections of natural gas consumption seem to indicate that natural gas supplies should survive the exhaustion of oil resources by 10 to 20 years, even though gas production is declining at a faster rate than oil production. This is because of the small amount of gas reserves that are actually discovered and measured. Production is initiated only when "proven" or measured reserves are sufficient to support production costs. Generally, investors require that gas fields support production for at least 12 to 15 years before development becomes worthwhile. In the United States, only 237 TCF, or 25 percent of the ultimately recoverable reserves, have actually been measured. This is an 11 to 1 ratio of proved reserves to production.



BB: BILLIONS OF BARRELS

Figure 1-16. PROJECTION OF U.S. OIL EXHAUSTION DATES (EXCLUDING IMPORTS AND ALTERNATIVE PRODUCTION POLICIES)

1.3.4 Coal Resources and Reserves

Two quite different elements are involved in coal. Traditional coal production and consumption methods are not socially or environmentally desirable. Many people feel that new and more acceptable methods should be developed to offset the impending exhaustion of the nation's other fossil energy sources.

Coal in its natural form is the least flexible of the fossil fuels. Since it is solid and contains substantial waste, coal is more difficult to use during various processing stages. Coal mining pollutes water, and waste piles are left behind. Surface mining scars the land, while underground mining creates subsident dangers. Sulfur and particulate matter in coal are major air pollutants. In addition, underground mining is an extremely dangerous occupation.

Coal's physical and chemical characteristics are responsible for its seesawing popularity. Because coal is the nation's most abundant fossil energy resource, the United States relies on it when it is deprived of other cleaner fuels. Figure 1-17 shows that coal's largest market is the electric utilities. In recent years, all other coal markets have been declining.

The United States has sufficient low-sulfur coal reserves to support production growth for the next few centuries. These environmentally acceptable coal deposits are located predominantly in the Northern Rockies (Figure 1-18) where, presently, there is virtually no major coal development. Also, the most lucrative of these western deposits would require surface mining. Local and state governments are understandably reluctant to permit the environmental and social disruptions that would accompany major development of these coal lands, especially when the coal would be used in midwestern and eastern markets.

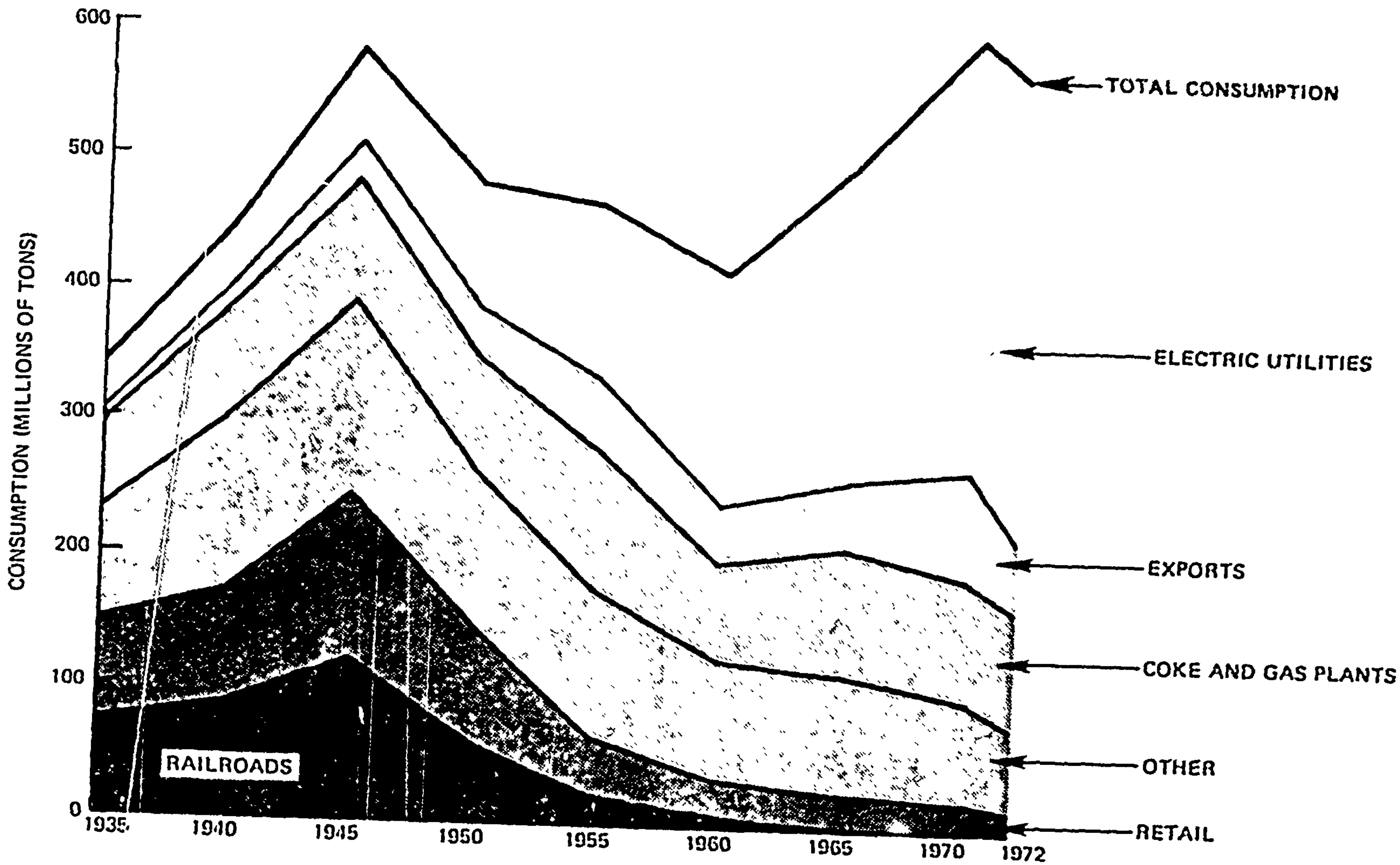
1.4 DOD'S ENERGY SITUATION

1.4.1 DOD's Energy Problem

The most serious and pervasive threat to long-term national stability is the growing world inadequacy of assured energy resources to support world needs. National security depends on maintaining a worldwide balance of the distribution of energy resources. National security objectives can be achieved only if the United States is thoroughly prepared to meet essential industrial and military energy requirements. Attaining these objectives, deterring armed conflict, producing modern weapons systems, and maintaining the overall readiness of the U.S. military, are all keyed to uninterrupted energy supplies.

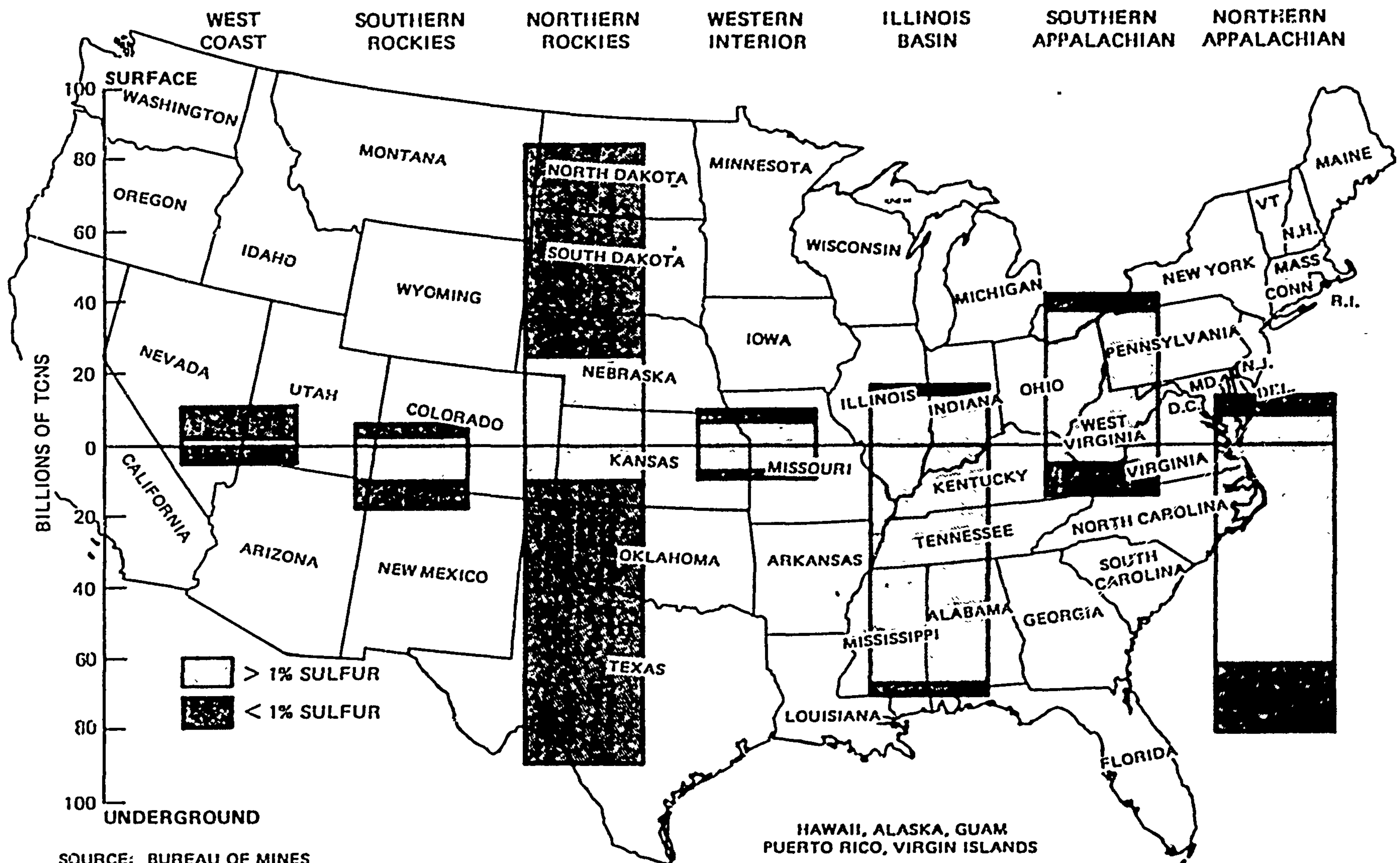
1.4.2 Current Energy Consumption Patterns

National defense depends on all forms of available energy, particularly portable fuels to support worldwide commitments on the seas, in the air, and on the ground.



SOURCE. NATIONAL ENERGY OUTLOOK, FEDERAL ENERGY ADMINISTRATION, 1976.

Figure 1-17. COAL CONSUMPTION BY SECTOR, 1935-1972



SOURCE: BUREAU OF MINES
DEPARTMENT OF THE INTERIOR.

Figure 1-18. DEMONSTRATED COAL RESERVES

Petroleum products make up 67 percent of the total energy used by DOD (Figure 1-19). Although DOD has significantly reduced petroleum consumption since FY 1973, the FY 1976 daily requirement is almost one-half million barrels, or nearly 2.7 percent of the national demand (Figure 1-20). Figure 1-20 shows that the Navy's share of DOD's requirement is about 154,000 barrels per day, or about 34 percent.

1.4.3 Summary

DOD is the government's largest energy consumer, using 0.21 BBOE, or about 2 percent of the national requirements for direct use in FY 1975 (Figure 1-19). Thus, DOD is vitally concerned with the impact of the nation's increasing reliance on foreign oil imports to meet domestic demands. The threat of disrupting a major portion of these imports and the severe national security problems posed by such action demand that steps be taken soon to decrease the nation's vulnerability to any action taken by a foreign country to interrupt U.S. oil imports. The long-term impact of the nation's dwindling natural petroleum supply is extremely important tc DOD.

Each sector of the U.S. economy relies on an uninterrupted flow of goods and services. Transporting these goods and services depends largely on portable fuels, which are critical to national security. All sectors of the economy rely on energy, but transportation is the only one that almost completely (98 percent) depends on liquid petroleum. Although other sectors will be able to use alternative energy sources such as coal, geothermal, solar, and nuclear power in the immediate future, the options available to transportation and defense are severely limited.

It is extremely important that initiatives be undertaken to develop new sources of energy, as well as promote the expansion of traditional energy sources. Figure 1-21 depicts the likely situation in 1985 and 2000 if new initiatives are not undertaken. By 2000, oil imports could constitute 83 percent of domestic oil needs.

1.5 THE NAVY'S ENERGY SITUATION

1.5.1 The Navy's Energy Problem

The Navy's mission, as outlined in Title X of the U.S. Code, is to conduct prompt and sustained operations at sea. In fulfilling this responsibility, the Navy provides its share of the nation's overseas forces and ensures the security of the sea lines of communication between the United States and its overseas forces and allies. Two principal functions are derived from the Navy's mission: sea control, the prerequisite for all naval operations, and projection of power.

The Navy is especially vulnerable to price raises, embargoes, and blockades by nations that have, or can achieve, control over major energy sources or supply routes. Also, political realities may deny the Navy any preferential access to prepositioned war reserves in the territories of other industrial nations, to energy from Naval Petroleum Reserves or Naval Oil Shale Reserves, or to the nation's domestic energy supply, through

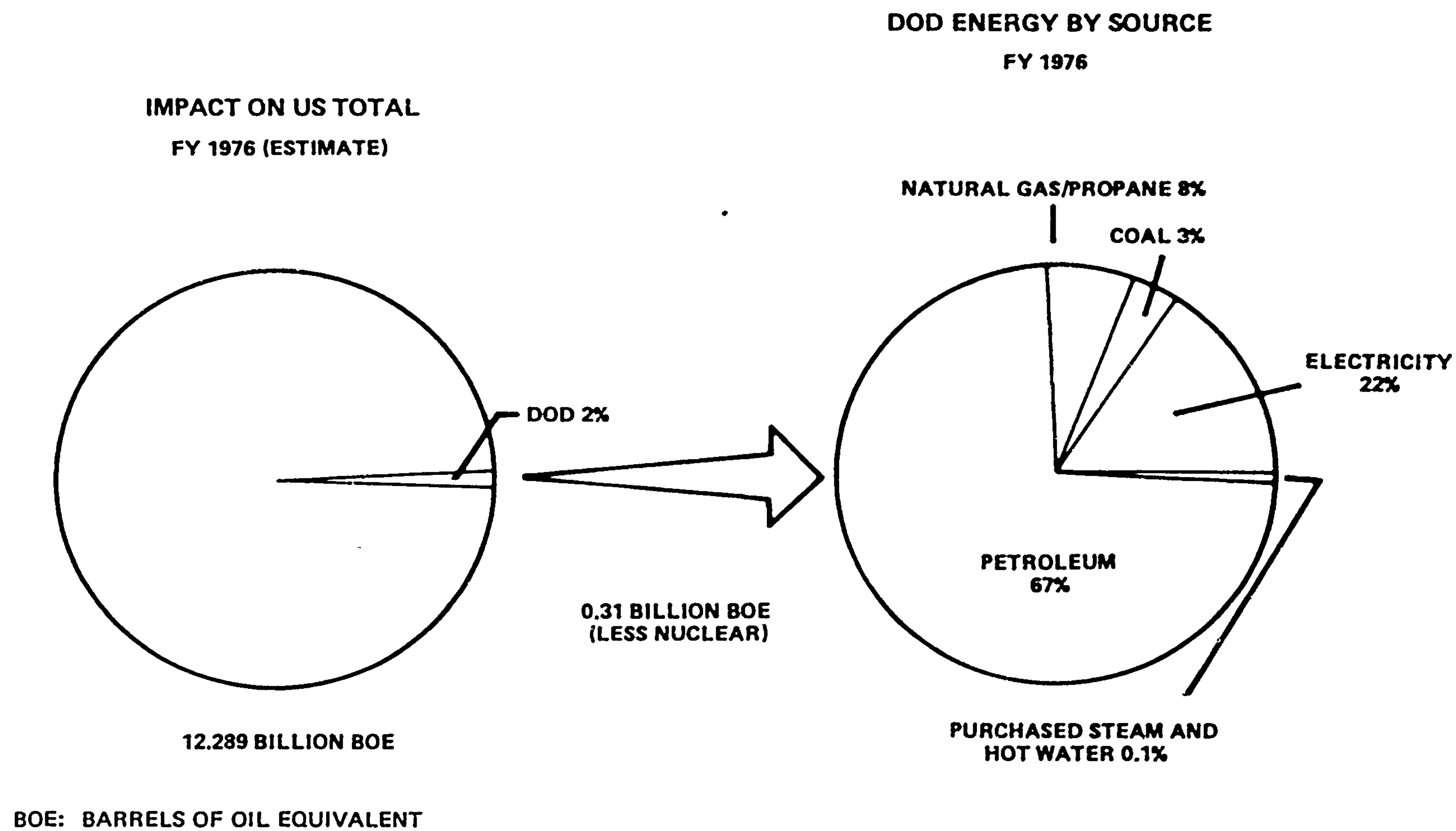
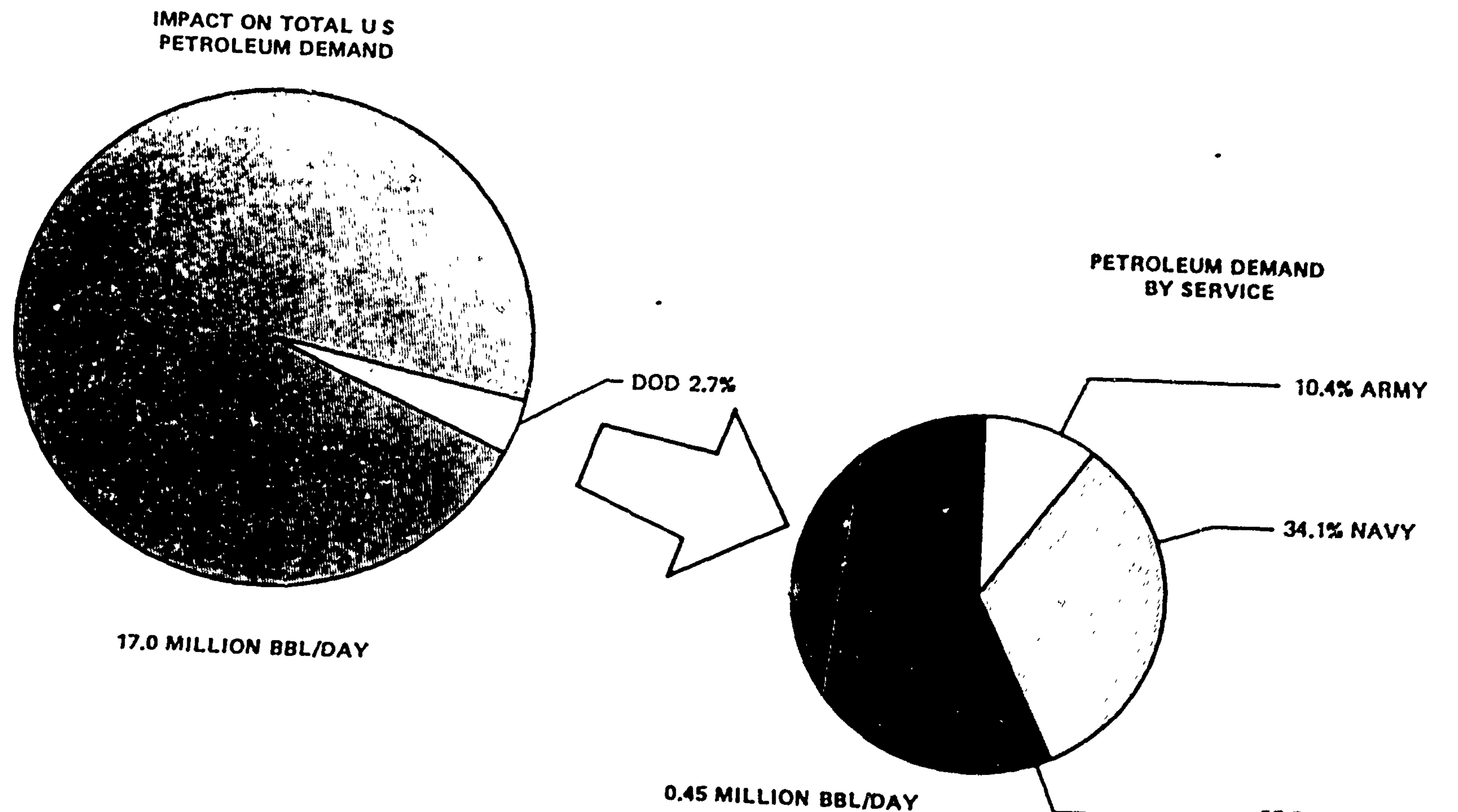


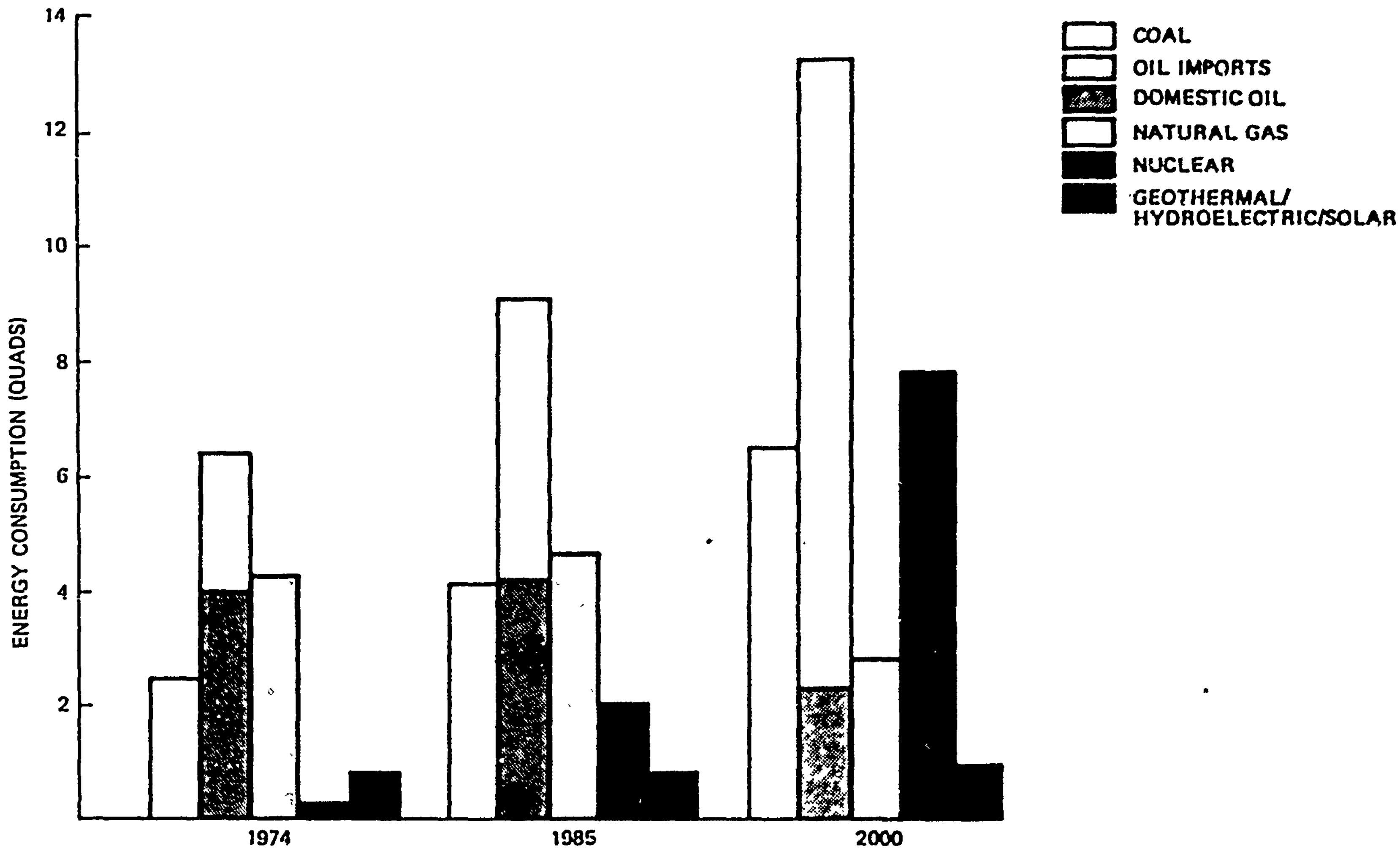
Figure 1-19. DOD ENERGY DEMAND
(EXCLUDING NUCLEAR)



SOURCE: DIRECTOR OF ENERGY, OASD(I&L), 10 DECEMBER 1976.

	BBL/DAY	
NATIONAL	17,000,000	CY 76
DEPARTMENT OF DEFENSE	451,000	FY 76
NAVY	154,000	FY 76

Figure 1-20. DOD PETROLEUM DEMAND, FY 1976



SOURCE: CREATING ENERGY CHOICES FOR THE FUTURE,
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, 1976

Figure 1-21. PROJECTED U.S. ENERGY CONSUMPTION
(NO NEW INITIATIVES)

implemention of the Defense Production Act, unless there is an immediate and clear military threat to the civilian population.

The Navy's energy problem is exacerbated by the technical reality that, although the trend is toward nuclear power for major combat ships and submarines, most major and all small ships and all aircraft will require liquid hydrocarbon fuels in the near future.

1.5.2 The Navy's Energy Consumption and Supply

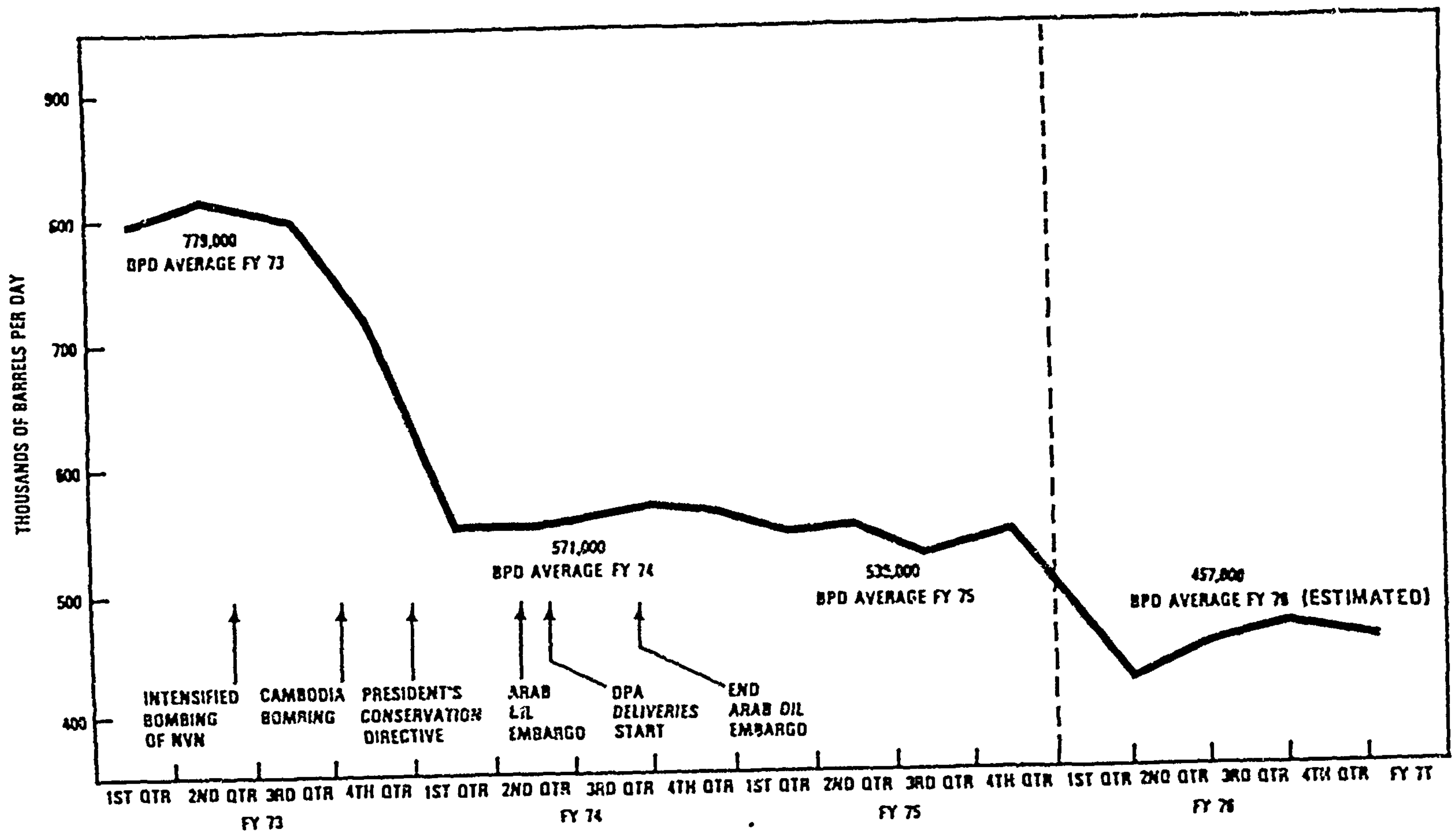
Figure 1-22 shows the recent history of the Navy's consumption of petroleum fuels. It clearly reflects the impact of reduced force levels during the Vietnam phasedown in FY 1973, the Arab embargo in FY 1974, the continuing energy conservation program since the embargo, and the recent rapid substitution of Navy distillate (ND) and diesel fuel marine (DFM) for Navy special fuel oil (NSFO) for ship propulsion. Specifically, since FY 1973, petroleum consumption has decreased 35.4 percent. Navy energy consumption by fuel type and consumer categories appears in Appendix A.

Figure 1-23 indicates that JP-5 and DFM/ND are the major fuels used by the Navy. JP-5 furnished 77 percent of the fuel used in the Navy's air operations in 1976, while JP-5 and DFM/ND supplied 93 percent of the fuel used in the Navy's ship operations. JP-4 and aviation gasoline constitute a small portion of aviation fuel supplies, NSFO and residuals make up an even smaller (and rapidly decreasing) percent of ship energy supplies.

Shore energy usage is more complex than aviation or ship usage. Motor gasoline and diesel fuel are used by ground vehicles. Gas and heating oil are used for space heating. Coal, residuals, NSFO, ND, diesel fuel, and JP-5 are used for steam and to generate electricity. Most purchased steam and electricity is generated by similar fuels.

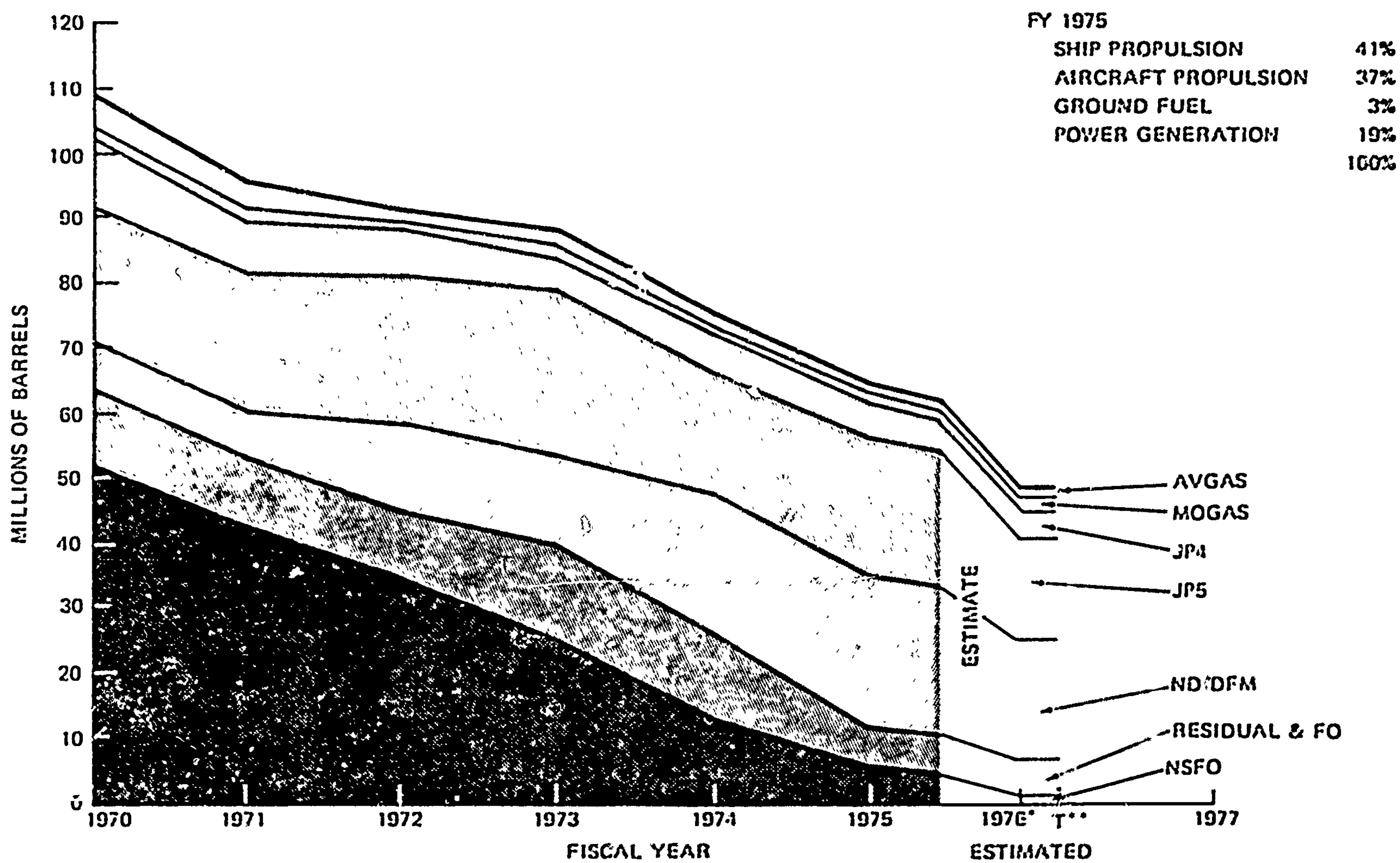
Previously, the Navy's policy had been to convert from generating electricity on-base to purchased electricity (this facilitates a shift to coal and/or nuclear-fueled generation) and to shift from residual/NSFO/ND to coal for generating steam. However, rising gas prices and regional gas shortages have made it necessary to change that policy. Today, the Navy's policy is to shift from gas to oil for space heating and to change to coal by using central steam plants to replace individual oil heaters.

It is primarily for economic reasons that the energy used by the Navy in CONUS is purchased from domestic refineries, and that the energy used overseas is purchased from overseas suppliers. Some of the fuel bought overseas, specifically the fuel used by the Sixth Fleet is produced from Libyan crude, and practically all of the rest comes from Middle East crude. This procurement policy will probably not change so long as there are significant energy imports to CONUS and no conflicts or crises. The possible curtailing of fuel supplies to the Navy from these overseas sources, because of a conflict or crisis resulting from either an action by (or against) the supplier or an interdiction of established tanker routes, is clearly a serious direct threat to Navy and other DOD operations overseas.



*INCLUDES "SALES TO OTHER:" FY 73, 52,000; FY 74, 27,000; FY 75, 23,000; FY 76, 24,000.   SOURCE: DIRECTOR OF ENERGY OASD(I&L) 15 AUG 75

Figure 1-22. DOD PETROLEUM CONSUMPTION TRENDS



*DEIS-I. PRELIMINARY DATA.
**ESTIMATED.

SOURCE: NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976.

Figure 1-23. NAVY FUEL CONSUMPTION
(INCLUDING MARINE CORPS)

1.5.3 Current Petroleum Fuel Prices

The Navy's petroleum requirements are based on the amount used during various activities, and are generally fulfilled, with the exception of shore facilities, through vendor contracts administered by the Defense Fuel Supply Center (DFSC). DFSC buys from the source offering the lowest laid-down cost; that is, the total cost of the product FOB, and the refinery plus transportation cost to the needed location. Table 1-1 shows the recent history of some selected DFSC standard prices. Shore facilities' petroleum requirements are primarily satisfied through individual contracts administered at the local level.

Table 1-1. DFSC STANDARD PRICES*

	JP-4	JP-5	AVGAS	NSF	DFM	ND	MOGAS
Jul 1969							
Gallons	127	.127	.170	.059	.120	.083	.150
Barrels	5.334	5.334	7.140	2.490	5.040	3.500	6.300
Jul 1971							
Gallons	.123	.123	.170	.089	.117	.104	.166
Barrels	5.166	5.166	7.140	3.730	4.914	4.350	6.972
Jul 1972							
Gallons	.124	.124	.170	.079	.116	.107	.150
Barrels	5.208	5.208	7.140	3.320	4.872	4.510	6.300
Jul 1973							
Gallons	.149	.162	.264	.092	.163	.132	.175
Barrels	6.256	6.804	11.088	3.8[illegible]8	6.846	5.544	7.350
Feb 1974							
Gallons	.277	.267	.264	.242	.200	.287	.245
Barrels	11.634	11.214	11.088	10.150	8.400	12.040	10.290
Jul 1974							
Gallons	.354	.340	.367	.356	.347	.369	.335
Barrels	14.868	14.280	15.414	14.944	14.574	15.502	14.070
Nov 1974							
Gallons	.373	.355	.437	.313	.339	.339	.381
Barrels	15.666	14.910	18.354	13.166	14.238	14.238	16.002
Jul 1975							
Gallons	.423	.408	.490	.361	.390	.390	.438
Barrels	17.766	17.136	20.580	15.162	16.380	16.380	18.396
Jan 1976							
Gallons	.368	.355	.427	.313	.339	.339	.381
Barrels	15.456	14.910	17.934	13.166	14.238	14.238	16.002
Oct 1976							
Gallons	.433	.385	.457	.313	.385	.385	.316
Barrels	18.186	16.170	19.194	13.116	16.170	16.170	13.272

*Above prices generally do not apply for shore utilities. See Table A-2.

1.5.4 The Navy's Future Energy Funding Requirements

A study has been completed that projects the Navy's energy funding requirements, in constant 1976 dollars and in current year dollars, for FY 1976 to FY 2000. The results of this study appear in Figures 1-24 and 1-25. The study estimates that the Navy's energy funding needs will increase from \$1.2 billion in FY 1976 to between \$7.2 billion and \$10.5 billion in FY 1995 (based on current year dollars). However, this assumes a 7 percent inflation rate by 1995. After 1995, when energy requirements will probably level off, the cost will continue to increase significantly, and by 2000, it will range between \$10.5 billion and \$18.1 billion. The Navy's best estimate of future energy requirments was obtained from the Navy Energy Usage Profile and Analysis System (NEUPAS) (Appendix B). Cost data is taken from various cases explained in Appendix C.

1.6 NEAR-, MID-, AND FAR-TERM ENERGY ALTERNATIVES

1.6.1 Near- and Mid-Term Energy Demand

It is clear that the United States will have to decide between either becoming increasingly dependent on foreign oil imports or changing its energy consumption patterns while developing new alternative sources.

Relatively little can be done in the near- (1980) to mid-term (1980 to 1985) to change energy demand patterns. Industrial and utility power plants have useful lives of up to 20 years. This means that alternative boiler systems will be phased in only after that time. However, there are two possible alternatives to business-as-usual energy consumption that can reduce the demand for oil and gas. The first is to strongly emphasize and practice conservation. The second alternative is to turn to electricity generated by coal-fired boilers or nuclear plants.

The first option is to emphasize conservation. This is an investment in energy saving technology such as improved gasoline engines, better building insulation, and hull cleaning methods, etc. Conservation directly reduces the amount of oil the nation needs, and, in the near-term, only conservation can directly affect the nation's dependence on foreign oil. Studies completed by FEA indicate that by adopting national policies, which promote energy conservation, the United States can reduce its need for oil from foreign sources by nearly 3 million barrels per day when compared with the business-as-usual case, by 1985. For this reason, ERDA has given energy conservation the highest priority. Currently, most federal energy conservation policies require voluntary support and cooperation from the general public. Very few direct incentives have been given to the public to curtail its consumption, and it will be only the increasing cost of energy that will discourage the consumer and change the present consumption pattern.

The other option is to turn to electricity generated by coal-fired boiler or nuclear plants, placing the burden of energy demands on the coal and nuclear power industries. However, results probably cannot be achieved in the near- to mid-term because of the lead-times involved in developing new mines and constructing new power plants.

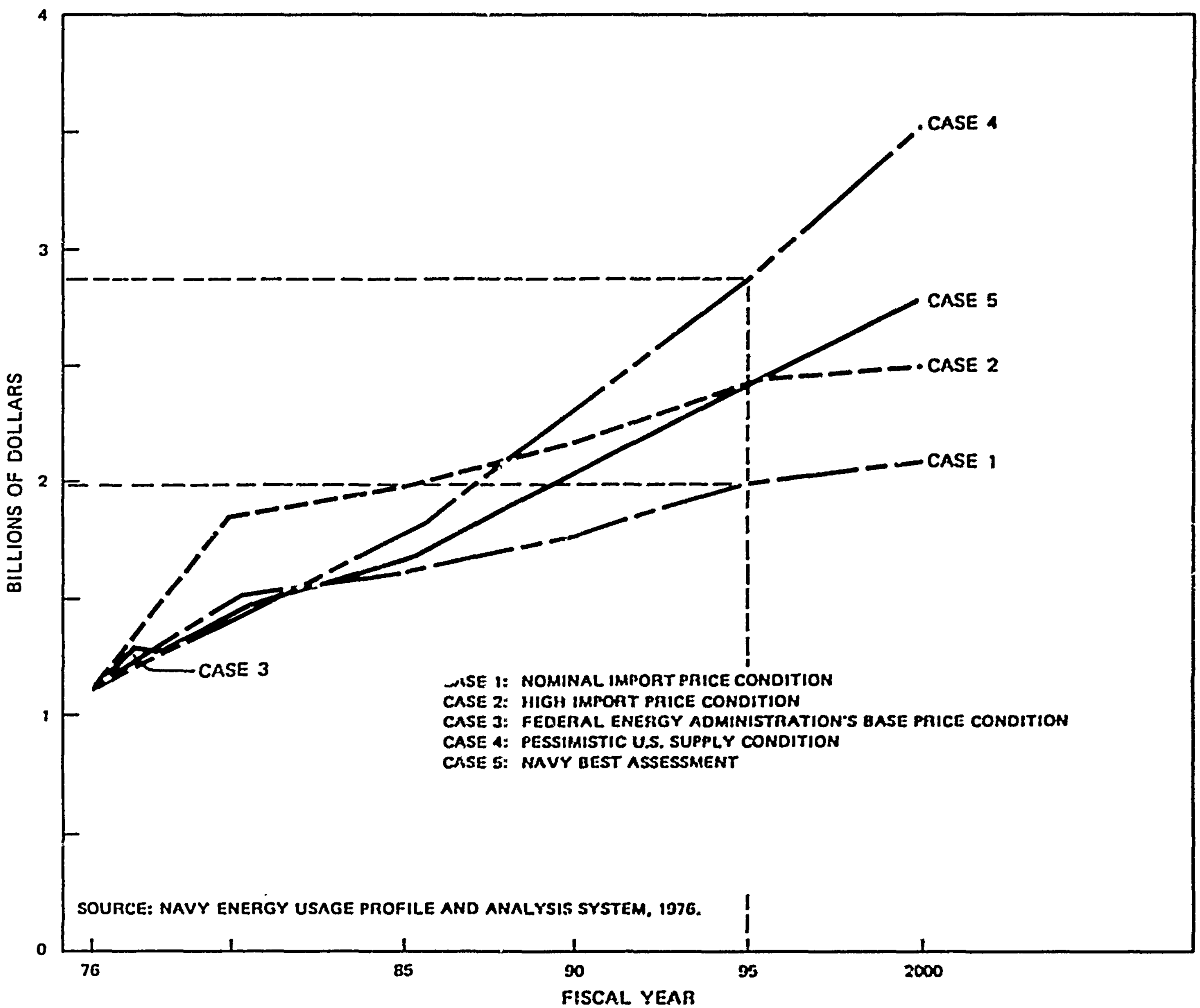


Figure 1-24. NAVY ENERGY FUNDING REQUIREMENTS, 1976-2000

Comparison of Cases (Constant 1976 Dollars)

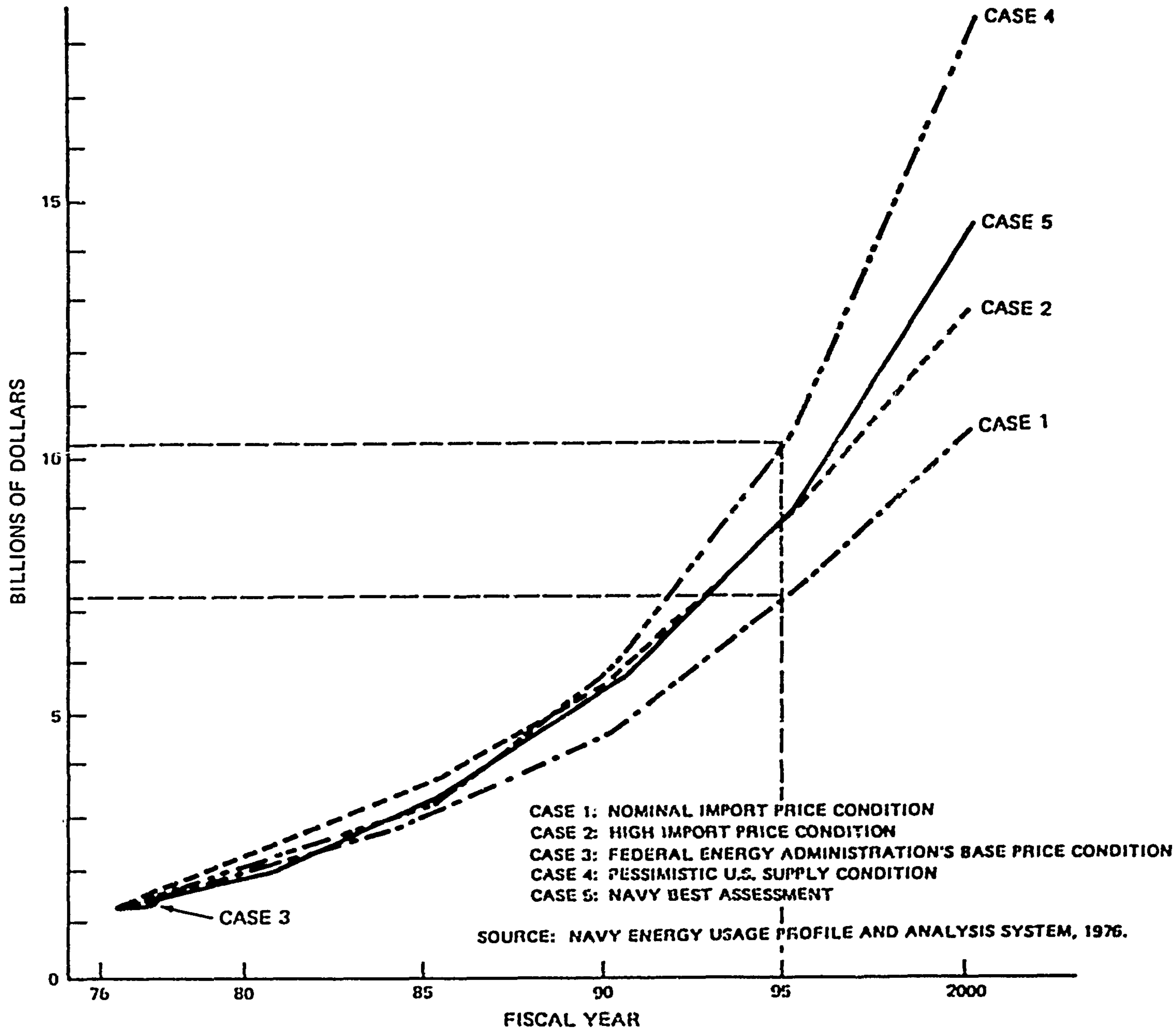


Figure 1-25. NAVY ENERGY FUNDING, 1976-2000
Comparison of Cases (Current Year Dollars; 7% Annual Inflation Rate)

Consequently, energy demand patterns are not easily altered. Shifting to new energy sources has usually required more than one-half century.

1.6.2 Near- and Mid-Term Energy Supply

Energy supply forecasts for the near-term are reasonably reliable. Most of the energy that will be supplied between now and 1980 will come from oil wells, gas fields, and coal mines that are currently producing. Considerable lead-times are needed for constructing new production facilities. Although production from these traditional sources will decline in the mid-term, the nation will be able to maintain some control over the origin of new energy sources. However, there are many opinions on what new sources should be developed. There are also many questions about the continued development of each traditional and new energy source that could promise returns in the mid-term. Table 1-2 lists the major issues that confront the nation in each of these sources. The fundamental issues raised show the obvious need for a carefully coordinated public energy policy.

Table 1-2. MAJOR ENERGY ISSUES

General	Optimal import strategy Growth versus no growth Divestiture or vertically-integrated oil companies Available capital
Oil	Decontrol of oil prices OCS leasing Alaskan oil distribution
Gas	Deregulation of natural gas Alaskan gas distribution
Coal	Surface mining legislation Reclamation SO_2 Emission standards
Nuclear	Nuclear reactor safety
Synthetic fuels	Federal incentives

1.6.3 Long-Term Energy Technology

A number of alternative energy sources are promising for the long-term. The United States and the rest of the world are far from exhausting all the practical, available energy sources. Energy sources that could constitute the nation's long-term energy supplies (of which at least five could be directly applied to the Navy's requirements) are: coal; crops; nuclear fission; nuclear fusion; geothermal; hydroelectric; natural gas; ocean heat; oil; oil shale and tar sands; solar; tides; waste heat; waste materials; water (fusion and hydrogen); and windpower.

Although the supply of some sources is unlimited, very little can be tapped from the new, more exotic sources in this century. The development cycle of light water nuclear reactors is an example. It required 33 years to evolve light water reactor technology and to introduce it commercially. Although other technologies may not need a long development period, all of them will require extensive laboratory, pilot, and demonstration scale tests before they are introduced commercially.

Today, only liquid metal fast breeder reactors (LMFBR) and synthetic fuels from coal and oil shale are ready for demonstration scale tests. It will be at least 5 to 10 years before the exact value of these two technologies is determined. The value of other less developed technologies will not be recognized for at least a decade. However, this assumes that the United States will be committed to the all out development of these technologies.

There are numerous significant barriers to the development of new energy technology. An uncertain policy probably contributes more to the delay than do technical, economic, and social considerations. Table 1-3 lists the major barriers for each of the emerging energy technologies.

Table 1-3. BARRIERS TO DEVELOPING ENERGY TECHNOLOGY

Technology	Issues and Areas of Uncertainty
Enhanced oil and gas recovery	Federal oil and gas pricing policies
Synthetic liquids and gases and direct utilization of coal	Federal energy policy Disposal of spent material Water consumption Strip mining and reclamation Sulfur oxide standards World oil prices Capital requirements
Geothermal	Lack of comprehensive resource information Lack of proven domestic technology Legal and regulatory complexities
Light water reactors	Limited uranium reserves
Liquid metal fast breeder reactors	Economic uncertainty Safety Radioactive waste management Insufficient engineering base (breeders) Fuel cycle performance (breeders)
Solar heating and cooling	Economic uncertainty Limited geographic applicability Need for conventional backup Legal complexities
Solar electric Solar thermal electric Solar photovoltaic Wind energy Ocean thermal energy conversion	Economic uncertainty Legal complexities Lack of proven technology
Fusion	Very early in the development cycle

Source: "Creating Energy Choices for the Future," ERDA, 1976.

1.6.4 Summary of Energy Alternatives

Limited choices confront the United States. The nation will continue to rely on foreign oil in the near-term. Energy independence in the mid-term could be achieved, but at a cost the nation may not be willing to pay. Long-term alternatives show great promise, but they may be too late to prevent large increases in foreign imports of liquid petroleum products.

Left to the pressures of free market economics, new alternative energy sources could be ultimately developed by private industry as traditional sources diminish and become more expensive. This depends on how industry assesses the capital investment risk. Consequently, as long as the opportunity exists to import cheaper energy sources, which, in turn, undercut the price of new domestic energy sources, private industry will be reluctant to develop new sources. As a result, the nation will increasingly rely on foreign sources until those sources diminish and profit from new domestic sources is assured.

Government policymakers recognize the problem and are trying to ensure the nation's commitment to the early development of its domestic energy alternatives. However, there are many alternatives that can be pursued, and each is accompanied by technical, economic, environmental, and social problems. Vast resources of nonrenewable energy sources, other than liquid petroleum, are available worldwide. The United States has major energy resources, as depicted in Table 1-4. The issues are complex and without an integrated national plan it is difficult for the Navy or other agencies to set priorities. Additionally, a national consensus, in some cases, may be needed to overcome the traditional economic barriers that confront the development of alternative fuels.

Table 1-4. ULTIMATELY RECOVERABLE WORLD ENERGY RESOURCES[a]
(Approximate percent of total)

	(Approximate percent of total)				
	Crude Oil[b]	Oil Shale[c]	Tar Sands[b]	Natural Gas[b]	Coal[c]
United States	7	73	2	10	27
USSR/China	27	12	–	33	62
Middle East	33	–	–	20	–
West Europe	4	1	–	5	4
Canada	4	12	38	5	1
Africa	9	1	–	8	1
Latin America/ South America	7	–	60	8	–
Other	10	1	–	11	5
Total	100	100	100	100	100
Total (in BBOE[d])	1,785	1,460	1,000	1,345	53,000

[a] Percentages are shown to indicate order of magnitude only.
[b] John J. Moody, "Petroleum Resources: How Much and Where?," 1975.
[c] 1974 World Energy Conference.
[d] BBOE: Billion barrels of oil equivalent.

2.0 THE NAVY ENERGY PLAN: CONCEPT, GOALS, STRATEGIES, AND OBJECTIVES

2.1 DEVELOPING THE NAVY ENERGY PLAN

The Navy recognizes the impact of the nation's energy problem and that:

- The United States depends on its least abundant fossil energy resource (natural petroleum) to provide the fuel for the majority of its energy needs.
- The nation's energy policy has been based on the assumption that there will be an unlimited supply of oil imports at attractive prices.
- National energy planning has not realistically taken into consideration the dwindling supply of domestic natural petroleum.

The first step in developing an energy plan is to recognize that petroleum will not continue to be the primary energy resource, and alternative resources must be developed. Although the strategic point at which this transition must occur cannot be precisely identified, short- (to 1985), mid- (to 2000), and long-term (beyond 2000), planning can be initiated.

Effective planning also requires that the Navy shift from a decentralized and fragmented approach to a centralized, well-coordinated, and integrated approach that considers all aspects of the energy problem in terms of energy goals, strategies, objectives, and policies. Since the basic U.S. strategy is a maritime strategy, the Navy must support that strategy beyond 2000, and be able to perform its assigned missions. The Navy's energy plan includes determining the basic long-term energy goals, adopting courses of action, and allocating necessary resources to achieve these goals. Energy resource planning is not static, but, rather it is dynamic and flexible. In turn, it must reconcile energy resources with such factors as cost, availability, mission design, and development assets (men, materials, money, etc.). This approach has resulted in a plan that describes the Navy's energy role beyond the traditional scope and limitations of the budget cycle and which considers the economic uncertainties of the next 25 years.

Figure 2-1 shows that the Navy's energy planning has two equally important parts: formulation and implementation. Formulation involves identifying problems, opportunities, available resources, national security demands, and national energy requirements. After clearly identifying the issues, reasonable alternatives and the risks associated with each course of action can be determined and examined.

Implementation includes developing an organizational structure to deal with identified problems and coordinating the necessary procedures to achieve goals, strategies,

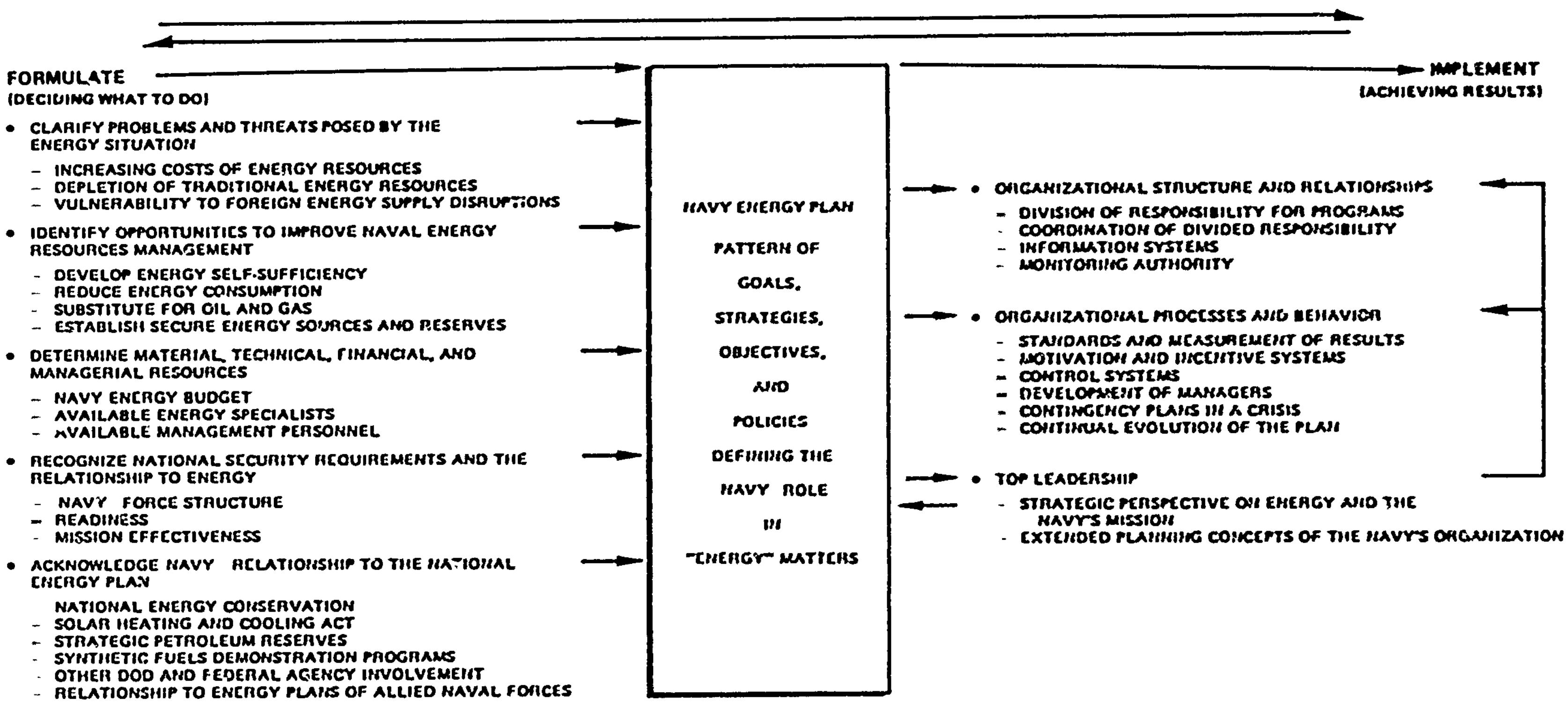


Figure 2-1. CONCEPT OF NAVY ENERGY PLANNING

objectives, and policies. Goals, strategies, objectives, and policies are defined in the Navy's energy plan as:

Goals—Overall, broad-based aims to be achieved according to the Navy's prescribed mission.

Strategies—Various approaches selected to meet the Navy's goals. Strategies combine selected objectives and policies to give a balanced approach.

Objectives—Specific end-points or positions to be attained. Different objectives may be combined into strategies and ultimately lead to achieving goals.

Policies—Command procedures or guidelines from which tasks or actions are developed. Policies provide the link that evolve objectives and strategies into Navy program actions.

Figure 2-2 shows the relationship between goals, strategies, objectives, and policies in the Navy's energy plan. From the Navy's mission, energy goals are determined. To achieve these goals, strategies and objectives are formulated. The Chief of Naval Operations (CNO) or appropriate command level authority guides the energy program activities by formulating policies. This provides the vital link between the energy plan and the programs that will ultimately achieve the energy goals.

The Navy Energy Office will coordinate the developing energy programs and policies at appropriate command levels. Where CNO policy input is required, it will be the Navy Energy Office that will review and select policy alternatives. Explicit guidelines appear in Section 2.4

The goals and objectives in the Navy's energy plan are flexible. Chapter 7 lists energy-related questions that should be reviewed to determine how the present energy objectives, policies, and guidelines apply to the Navy and to assess their potential impact and benefit to the Navy. Continual review of these questions will assist in the revision or formulation of additional objectives and policies.

2.2 NATIONAL ENERGY GOALS AND STRATEGIES

The national energy goals stated by the President in his 1975 State-of-the-Union message and reaffirmed in his 1976 energy message are to:

- End the nation's vulnerable position, by 1985, to actions by foreign nations to disrupt our energy flow.
- Develop our domestic energy technology and resources so that the United States can supply a significant share of the energy needs of the free world by the end of this century.

The national energy strategies to attain these goals include:

- Reduce dependence on foreign energy sources.
- Develop alternative energy sources such as synthetic fossil fuels, nuclear, solar, geothermal, and wind.

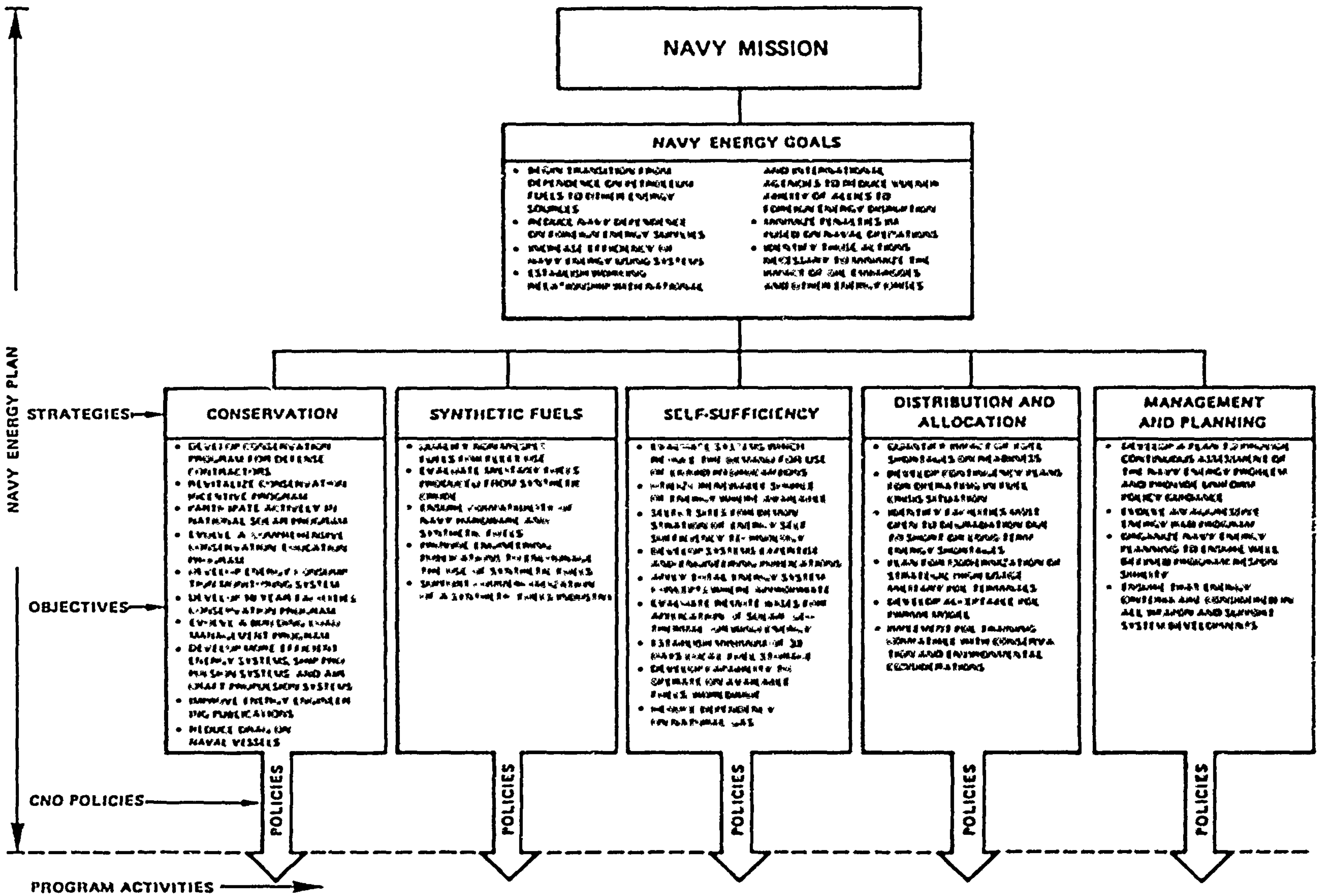


Figure 2-2. NAVY ENERGY PROGRAM ACTIVITY

- Increase domestic natural gas, petroleum, and coal production.
- Increase emphasis on energy conservation in the public and private sectors.

2.3 DOD'S ENERGY GOALS AND STRATEGIES

DOD's energy goals and strategies are very similar to the national goals. They are to:

a. Maintain conservation momentum while meeting readiness needs.

b. Seek to retain mandatory allocation for petroleum and initiate conversion to coal.

c. Maintain prepositioned war reserve requirement levels and establish and fund a five-year fuel storage improvement plan.

d. Support exploration and development of the Naval Petroleum Reserves.

e. Establish and fund a five-year facility conservation program.

f. Focus the energy-motivated research and development program on DOD's mission, and participate in Project Independence.

g. Consider energy effectiveness in weapons systems development.

h. Maintain energy management organizations in DOD and each of the military services.

2.4 THE NAVY'S ENERGY GOALS AND STRATEGIES

2.4.1 Introduction

During this initial phase, the Navy's primary energy goals, strategies, objectives, and policies are being defined. During the second phase, the program managers and fleet and shore commanders must review this plan, evaluate the implications, formulate action programs, and develop the policies necessary to carry out the plan.

2.4.2 The Navy's Energy Goals

The Navy's energy goals parallel national and DOD goals. They are to:

a. Begin the transition from depending on natural petroleum fuels to using alternative energy sources, where possible.

b. Reduce the Navy's reliance on foreign energy supplies.

c. Increase the efficiency and reliability of the Navy's energy-dependent systems without compromising flexibility, readiness, or performance.

d. Establish a cooperative working relationship with national and international agencies to achieve national energy goals, and assist in reducing the nation's vulnerable position to actions by foreign suppliers to disrupt our energy flow.

e. Minimize the penalties imposed on the Navy's operations that are caused by increased fuel prices.

f. Determine the necessary steps to be taken to continually ensure the Navy's energy future, especially in the event of oil embargoes, limited wars, and limited interdiction of U.S. and allied fuel supplies.

g. Establish quantifiable energy conservation goals:
   - Mobile operations (ship, aircraft, and vehicles) will maintain total nonrenewable energy use at the consumption rate established during FY 1975.
   - Shore facilities (utilities) will reduce energy consumption 15 percent from the adjusted FY 1973 baseline.

2.4.3 The Navy's Energy Strategies

There are five approved Navy energy strategies: energy conservation; synthetic fuels: energy self-sufficiency; energy distribution and allocation; and energy management planning.

Energy conservation strategy primarily emphasizes the Navy's energy conservation in two broad categories: reducing inefficient and wasteful energy use and restraining energy use.

The synthetic fuels strategy supports and is closely coordinated with national programs in synthetic fuels. This is to ensure that the Navy's ships and aircraft can operate on synthetic fuels derived from oil shale, coal, and tar sands, and that the Navy's shore facilities can use these alternative fuels to meet their energy needs.

Energy self-sufficiency strategy leads to the development of a level of self-sufficiency in the Navy's forces, thus reducing the impact of a disruption in energy supplies. It supports and is closely coordinated with national programs so that alternative energy sources including solar, geothermal, tidal, etc. can be evaluated for the Navy's use.

Energy distribution and allocation strategy supports a worldwide energy distribution and allocation system that can efficiently furnish necessary energy supplies to the Navy's forces in the form and quality required to ensure that there will be no mission degradation caused by domestic or worldwide energy shortages.

Energy management planning strategy initiates comprehensive energy management planning for the short-, mid-, and long-term to continually review priorities and programs that are necessary to minimize the adverse effect of energy problems.

2.5 THE NAVY'S ENERGY OBJECTIVES

The Navy has established specific energy objectives within the various strategies. These objectives are coded "U" or "NU" to indicate whether projects are underway (U) or not underway (NU). Those not underway are still in the planning stages.

2.5.1 Energy Conservation

a. Encourage development of a comprehensive energy conservation program by all defense contractors (contracts over 1 million dollars). (NU)

b. Revitalize the Navy's energy conservation incentive awards program that is presently incorporated in the Navy-wide beneficial suggestion program. (NU)

c. Provide RDT&E assistance to coordinate and evaluate the technology flow between the nation's and the Navy's energy programs. Programs that apply include: (NU)
   - Geothermal
   - Solar
   - Energy storage
   - Solid waste disposal
   - Synthetic fuels.

d. Evolve a comprehensive energy conservation education program for the Navy's personnel and their dependents stationed in U.S. government housing overseas. (NU)

e. Develop a system to fully monitor energy consumption by shore and fleet commands. (U)

f. Organize and implement a 10-year energy conservation facilities program. (U)

g. Explore alternative approaches to reduce energy consumption in family housing and shore-based utilities. (U)

h. Establish a building load management program for all major buildings, including an initial survey, and install controls by 1985. (NU)

i. Develop, test, and evaluate more efficient shore-based energy systems. (U)

j. Develop, test, and evaluate more efficient propulsion and auxiliary systems for existing and future Naval vessels. (U)

k. Improve engineering publications, equipment operating procedures, and technical expertise to encourage energy conservation. (U)

l. Reduce drag on the Navy's vessels. (U)

m. Establish operating procedures for ships to minimize fuel consumption under stated operation conditions. (NU)

n. Investigate and implement more effective training devices and simulators. (U)

o. Test and evaluate more efficient aircraft propulsion systems. (NU)

p. Develop and implement invaporative fuel recovery and conservation techniques. (U)

q. Implement total energy system concepts at the Navy's facilities, as appropriate. (U)

r. Implement the Lockheed JETPLAN flight planning and fuel management system for all applicable aircraft. (U)

s. Develop an increased capability for "cold iron" support of the fleet. (NU)

2.5.2 Synthetic Fuels

a. Investigate and qualify a wide range of non-MILSPEC fuels to be used by the fleet in the event that normal fuel supplies are disrupted or unavailable. (U)

b. Determine characteristics of military fuels produced from synthetic crude. (U)

c. Test, evaluate, and develop engineering solutions to ensure that synthetic fuels and the Navy's hardware are compatible. (U)

d. Support a commercial synthetic fuels industry by providing consumer markets, where appropriate. (U)

e. Evaluate and implement solid waste and waste oil energy recovery techniques. (U)

f. Eliminate the need for additives in aviation fuel without weapons systems or mission degradation. (NU)

2.5.3 Energy Self-Sufficiency

a. Test and evaluate energy systems to promote self-sufficiency and/or reduce the demand for liquid hydrocarbons. (U)

b. Utilize, where available, renewable energy sources such as geothermal, wind, solar, or others. (U)

c. Determine at which remote bases energy self-sufficiency would be workable, taking strategic value and any significant logistics savings into consideration (applying solar, geothermal, wind, etc.) (NU)

d. Establish a minimum of 30 days fuel storage at the Navy's facilities to meet local needs. (U)

e. Reduce family housing energy consumption through alternative approaches (solar, geothermal, etc.). (U)

f. Find alternative mobile energy sources for expeditionary forces. (NU)

g. Ensure a source of alternative energy supplies at critical military and industrial sites. (U)

h. Ensure that the Navy will be able to operate on any worldwide available fuel. (NU)

i. Guarantee that, by 1985, all shore facilities will be able to operate on renewable or alternative fuels. (U)

j. Ensure that remote operating bases become energy self-sufficient. (NU)

k. Investigate using solar energy and wind turbines aboard ship as auxiliary energy sources. (NU)

l. Develop an engineering publication that will provide guidelines and decision criteria to implement a base-wide self-sufficiency system. This will include geothermal, solar, wind systems, etc., as applicable. (U)

2.5.4 Energy Distribution and Allocation

a. Quantify the impact of fuel shortages on readiness. (U)

b. Guarantee that the Navy's energy logistics system is able to respond in a crisis. Examine selected energy policy analysis questions to develop contingency plans. (U)

c. Identify those facilities that would be most likely to suffer mission degradation caused by short-, mid-, and long-term energy shortages. (NU)

d. Prepare programs to modernize strategic and high usage military POL terminals (for example, Norfolk, Rota, Sasebo, Subic Bay) to accommodate tankers up to 80,000 DWT. (NU)

e. Guarantee that critical amounts of fuel can be stored in DOD's facilities. (NU)

f. Establish a POL PWRMR model that accurately reflects needs and is adaptable to Joint Chiefs of Staff (JCS) criteria in POL PWRMR planning. (U)

g. Organize and implement a POL training program, which will include conservation and environmental considerations that will be responsive to the Navy's present and future operations on shore and at sea. (U)

2.5.5 Energy Management Planning

a. Evolve an energy and critical materials plan and procedures for the Department of the Navy to continually assess the Navy's energy problems and to give uniform policy guidelines for all the Navy's agencies. (U)

b. Revise energy research and development programs based on policy guidelines in the Navy's energy and critical materials plan. (U)

c. Ensure that the operating characteristics and needs of the Navy's weapons and support systems are constructively weighed against energy requirements at various development stages. (U)

d. Develop a financial investment plan so that energy cost savings are available to offset energy costs, additional operational readiness and training is provided, and it is a source of investment capital for research projects that have a potential future payoff. (NU)

2.6 THE NAVY'S ENERGY POLICY AND RESPONSIBILITY

2.6.1 Policy

In accordance with national and DOD policy, it will be the Navy's policy to undertake the objectives outlined in Section 2.5 and to achieve the goals defined in Section 2.2. The policies will ensure that, as far as is practical, the Navy's future capabilities, under crisis or emergency conditions, will not be jeopardized by shortages of POL or energy in any form anywhere in the world. Also, the policies will guarantee that the operating characteristics and needs of the Navy's installations and facilities, weapons systems, and weapons support systems are constructively balanced against energy requirements throughout their life cycles.

2.6.2 Responsibility

Responsibility for undertaking the defined objectives are assigned to:

Chief of Naval Operations (OPNAV-413)

a. Coordinates all the Navy's energy matters. In so doing, establishes a balanced approach to all aspects of fleet and support operations for efficient energy management and utilization.

b. Acts as the resource and program sponsor for specific energy programs including the Navy's energy research and development.

c. Monitors progress of established objectives, gives direction and assistance, where necessary, and evolves new objectives, as required.

d. Takes necessary action on those energy objectives, within his functional responsibility, including those concerned with PWRMR and energy planning.

e. Ensures that energy objectives consider environmental protection regulations as outlined in OPNAVINST 6240.3D.

Chief of Naval Material (MAT-03Z)

a. Provides program management for specific energy RDT&E initiatives to support energy objectives.

b. Implements energy conservation actions according to OPNAVINST 4100.5.

c. Furnishes the Navy Energy Office with information and status of energy RDT&E programs, when required.

d. Supplies the Navy Energy Office with projected consumption data from NEUPAS to determine potential objectives and course of action.

Naval Facilities Engineering Command

a. Acts as the technical sponsor and central contact for energy conservation ashore.

b. Takes necessary action on those energy objectives that are within its functional responsibility.

c. Provides the Navy Energy Office with information and status on energy conservation programs and energy consumption of shore facilities on an, as required, basis.

d. Acts as the DEIS-II program manager.

Systems Commands and Major Claimants

a. Takes necessary action on energy objectives that are within their functional responsibility.

3.0 THE NAVY'S ENERGY PROGRAMS

3.1 INTRODUCTION

This chapter, summarizing the Navy's major energy or energy-related programs, clearly defines and delineates the programs and functions, if actively pursued, that can be instrumental in effectively managing available energy resources. These programs include:

- Energy conservation programs.
- Energy conservation research and development.
- Navy incentives awards program.
- Training devices (simulators).
- Synthetic fuels research and development.
- Energy self-sufficiency research and development.
- Navy/federal agency energy demonstration projects.
- Prepositional war reserve materiel petroleum requirement.
- Modernizing the Navy's POL facilities.
- Standardizing fuel.
- Pollution abatement control.
- Defense Energy Information System (DEIS).
- Navy's energy management and planning program.

3.2 ENERGY CONSERVATION STRATEGY

3.2.1 Base-Wide Command Energy Conservation Programs

OPNAVINST 4100.5, of 13 June 1974, directed that specific action be taken to achieve an overall 15 percent energy reduction at shore activities, as compared with 1973, or, at least, level consumption, as compared with 1975. CNO's objective is to attain the minimum energy consumption level possible at the operations and base-loading level, while meeting mission requirements and remaining within environmental and economic limitations established by the federal government.

NAVFACINST 4100.6, of 29 March 1974, had previously initiated a coordinated Navy-wide shore facilities energy conservation survey program to assist installation commanders in achieving specific energy conservation actions directed by CNO. Essential guidelines have been provided for local instructions and operating procedures for each field activity to implement CNO's energy conservation policies. The responsibility for developing, implementing, and monitoring the results of a base conservation program rests with the Commanding Officer. The DEIS-I and DEIS-II reporting system and visits of the Navy's Inspector General help monitor the progress of energy conservation goals.

The base-wide program outlines criteria and procedures for energy conservation involving: heating and hot water; air-conditioning and refrigeration; electricity; maintenance of equipment; use of nonessential facilities; car pooling; speed limits for government vehicles; and maintenance of facilities.

It is noteworthy that, based on the Inspector General's visits and actual monitoring of consumption data, there have been significant reductions that have occurred because of many individual Navy personnel decisions and actions. Important results have been accomplished, especially where there has been strong management interest in energy conservation. Although possible savings still exist, in most cases the emphasis must shift toward capital investment to improve efficiency.

3.2.2 The Naval Facilities Engineering Command (NAVFAC) Energy Program

3.2.2.1 Background

Shore facilities, which include Navy, Marine Corps (active and reserve) and government-owned contractor operated plants (GOCOs), (excluding ground support equipment such as transportation vehicles), represent one of the Navy's primary energy consumption areas. This area had a total energy cost of almost $400 million in FY 1975. It is possible that expenditures will be more than $800 million in FY 1985. These high costs accentuate the need for and importance of an effective energy engineering program that will ensure mission support with minimum energy use and waste. This program, initiated before the 1973 energy crisis, has evolved from a low priority to a major technical effort. NAVFAC is the technical sponsor and central contact for energy conservation ashore and is primarily responsible for the energy engineering program.

Policy and procedural guidelines to implement and continue the Navy-wide energy conservation program for shore installations, including GOCOs, is found in OPNAVINST 4100.5, of 13 June 1974.

The overall objective of this program is to maximize energy savings ashore, as consistent with maximum fleet readiness support, through an integrated approach to planning, designing, constructing, operating, and maintaining shore facilities. Other objectives are to:

- Reduce energy use in facilities by 25 percent.
- Decrease energy requirements in new buildings by 50 percent by improving traditional design.
- Eliminate natural gas use in boilers by 1985.
- Reduce fuel oil use by 50 percent by 1985.

Figure 3-1 depicts these objectives (base year 1973 has been adjusted). Figure 3-2 shows projected energy consumption to 2000.

Although energy savings from capital investment projects of the energy engineering program have not yet been achieved, the dollar savings from the shorter-term conservation actions, which were implemented in FY 1974, have been significant. These actions included energy surveys, boiler efficiency programs, reducing temperatures and lighting levels, and waste recovery and use. (See Table 3-1.)

Table 3-1. NAVY'S SHORE FACILITIES ENERGY CONSERVATION SAVINGS

	Percent Conservation (Over base FY 1973)	Barrels of Oil Equivalent Saved (Millions)	Dollar Value Savings (Millions)
FY 1973	Base Period	Base Period	Base Period
FY 1974	11.7	4.2	36
FY 1975	10.6	3.8	42.9
FY 1976 (3 quarters)	13.7	4.9	61.8

These savings were accrued when the historical energy usage trends, before FY 1974, were increasing; for example, average annual electricity consumption increased 3.5 percent. Furthermore, the decrease in fleet steaming hours (OPTEMPO) in recent years has precipitated an increased demand in utilities used for cold iron support for ships in port.

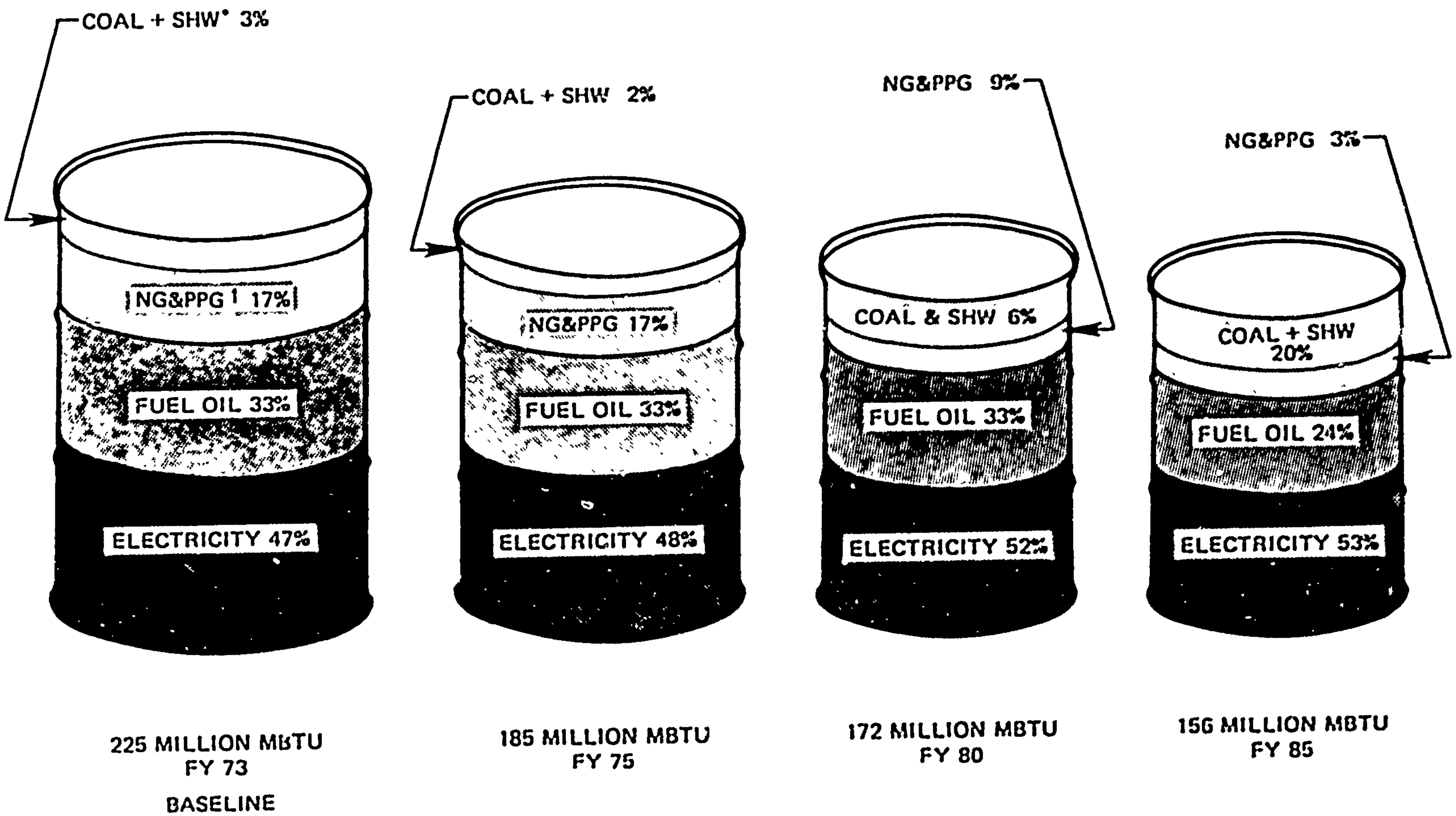
Table 3-2 shows FY 1975 energy consumption/conservation for shore facilities.

Table 3-2. NAVY'S SHORE FACILITIES ENERGY USE

Energy Source	FY 1976 Usage	FY 1976 Cost	Percent Conservation FY 1976/1973*
Purchased electricity	94,801,127	$214,201,513	8.4
Fuel oil	55,868,014 MBTU	128,496,432	16.2
Natural gas	28,248,140	35,027,694	20.2
Propane	849,909	3,467,629	34.0
Coal	2,599,248	3,716,925	39.0
Purchased steam and hot water	1,083,345	3,867,542	30.1
Total	183,449,783 MBTU	$388,777,735	13.7

*Percent reduction reflects FY 1976 usage and adjusted FY 1973 baseline, as reported in DEIS-II.

The large amount of total energy used on shore facilities, reflected in barrel oil equivalents (BOE), is significant when it is compared with the overall amount of energy consumed by the Navy. Table 3-3 shows that curtailing operations, a growing emphasis on trainers (simulators), and using cold iron has caused an increased percentage of the Navy's total energy to be consumed on shore facilities.



*SHW: STEAM AND HOT WATER
†NG&PPG: NATURAL GAS AND PROPANE GAS

Figure 3-1. UTILITIES USAGE ASHORE WITH ENERGY ENGINEERING PROGRAM

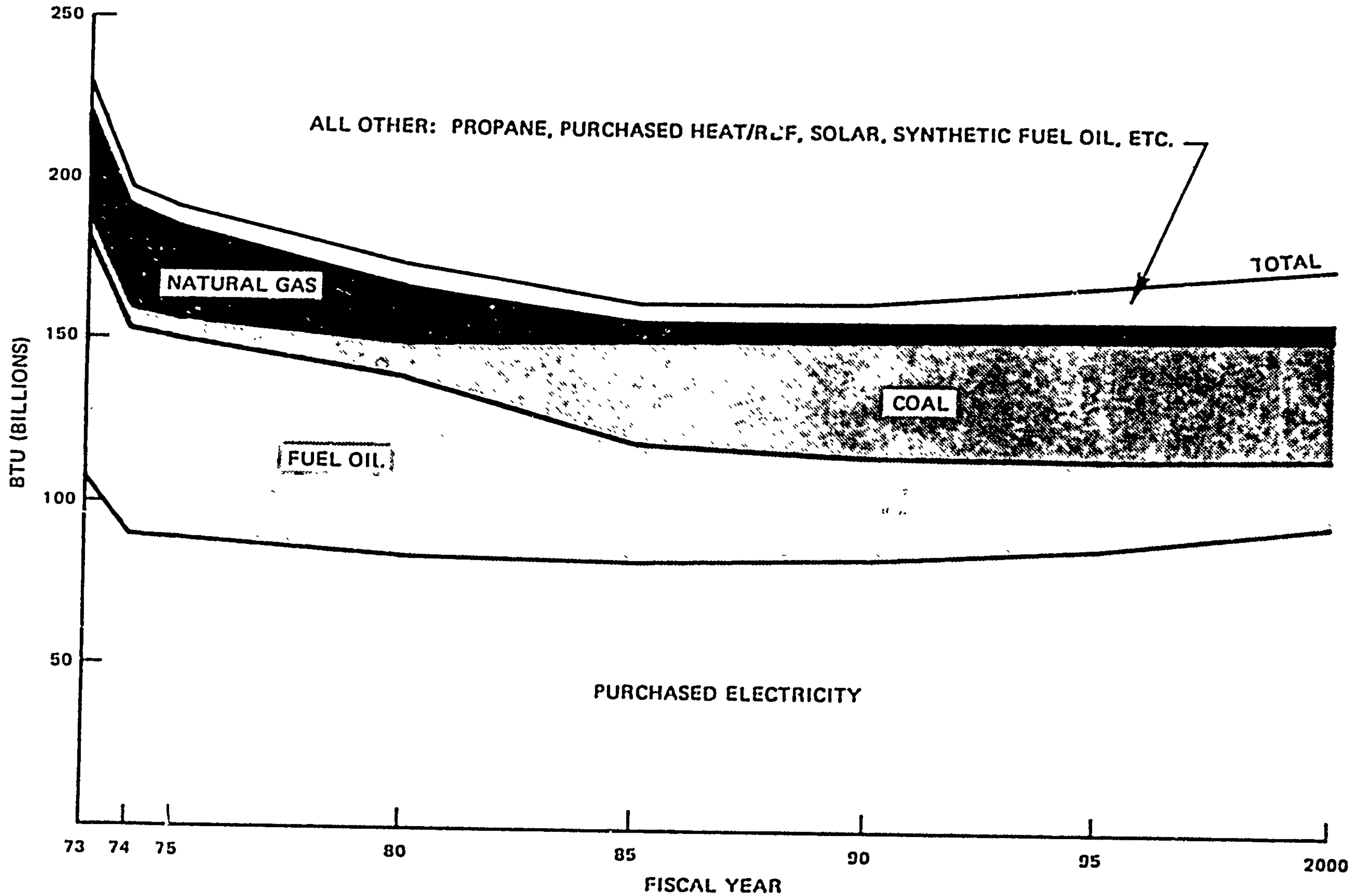


Figure 3-2. NAVY PROJECTED SHORE FACILITIES ENERGY CONSUMPTION

Table 3-3. NAVY'S TOTAL ENERGY USE
(Percent)

	FY 1973	FY 1974	FY 1975	FY 1976
Ships	39	35	33	29
Aircraft	26	27	27	28
Shore facilities	33	36	37	40
Ground support equipment	2	2	3	3
Total	100	100	100	100

Source: DEIS-I and DEIS-II.

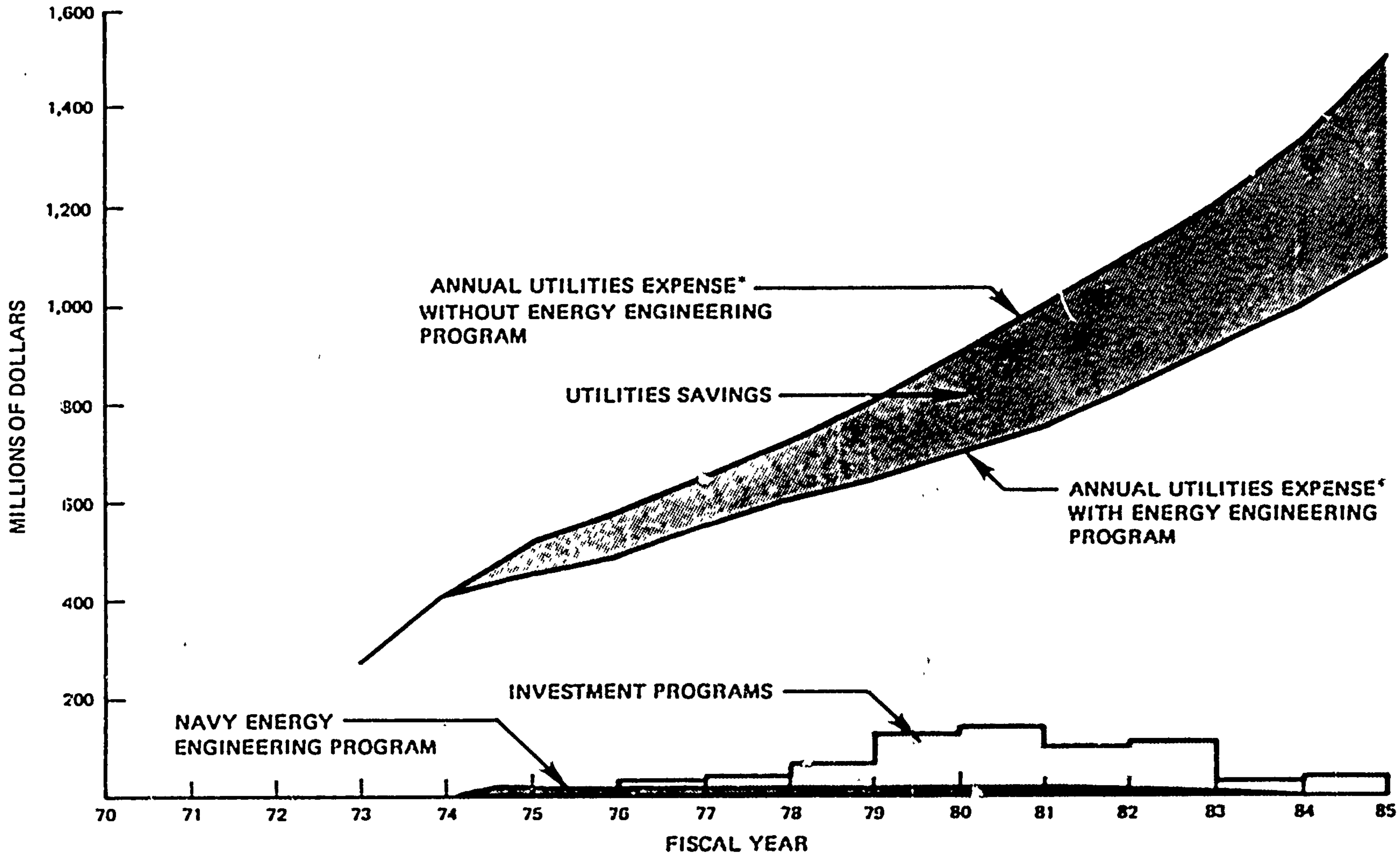
Although shore energy usage is being effectively managed, energy costs continue to increase, particularly for natural gas and electricity. Petroleum prices are still rising, but at a lower rate since the severe 1974 to 1975 OPEC increase. Notwithstanding the 13.7 percent reduced energy usage over FY 1973, the energy bill for utilities in FY 1976 was 212 percent of the FY 1973 cost.

Figure 3-3 shows total investment and total expected savings in the Navy's proposed energy engineering program. The curves at the bottom of the chart depict the yearly investment levels of O&M, MILCON, and other areas that will support the facilities' energy program proposed by NAVFAC over the next 10 years.

The two curves at the top of the chart show annual utilities expense with and without the proposed program (maintaining a 15 percent conservation rate is included in both curves). Although the chart only goes to 1985, utilities savings will continue beyond that year at a level of several hundred million dollars per year.

Figure 3-4 is derived from Figure 3-3. Figure 3-4 shows the potential cumulative energy savings in dollars, which is plotted against the cumulative investment in the energy engineering program. A breakeven point in 1982 indicates savings escalate as energy costs increase. Essentially, the breakeven point occurs at the estimated time when the total dollars invested in the proposed energy engineering program will be repaid by energy dollars saved. The energy investment and savings curves in Figure 3-4 are based on an annual expected energy cost increase of 10 percent (see Appendix C for discussion of price projection). This level is conservative and would be higher if energy cost increases exceed 10 percent. For instance, if energy costs grow at a rate of 15 to 20 percent, as some experts predict, the breakeven point would occur in 1980.

The challenge of meeting energy conservation goals on the Navy's shore facilities is directly related to the various conditions under which shore facilities operate. When extremes of climate, available essential energy sources, cost of essential energy sources, diverse mission responsibilities, and the existing condition of facilities and utility systems are balanced against providing a safe, comfortable, and efficient personnel environment, it is easy to see that this program is extremely site specific. This challenge is being met by a comprehensive program structured to satisfy mission requirements, while systematically applying economic criteria such as payback and cost/benefit analyses to identify and select new technology and energy alternatives.



*INCLUDES OPERATIONS AND ENERGY COSTS

Figure 3-3. NAVY AND MARINE CORPS CONSERVATION PROGRAM SAVINGS FOR SHORE FACILITIES

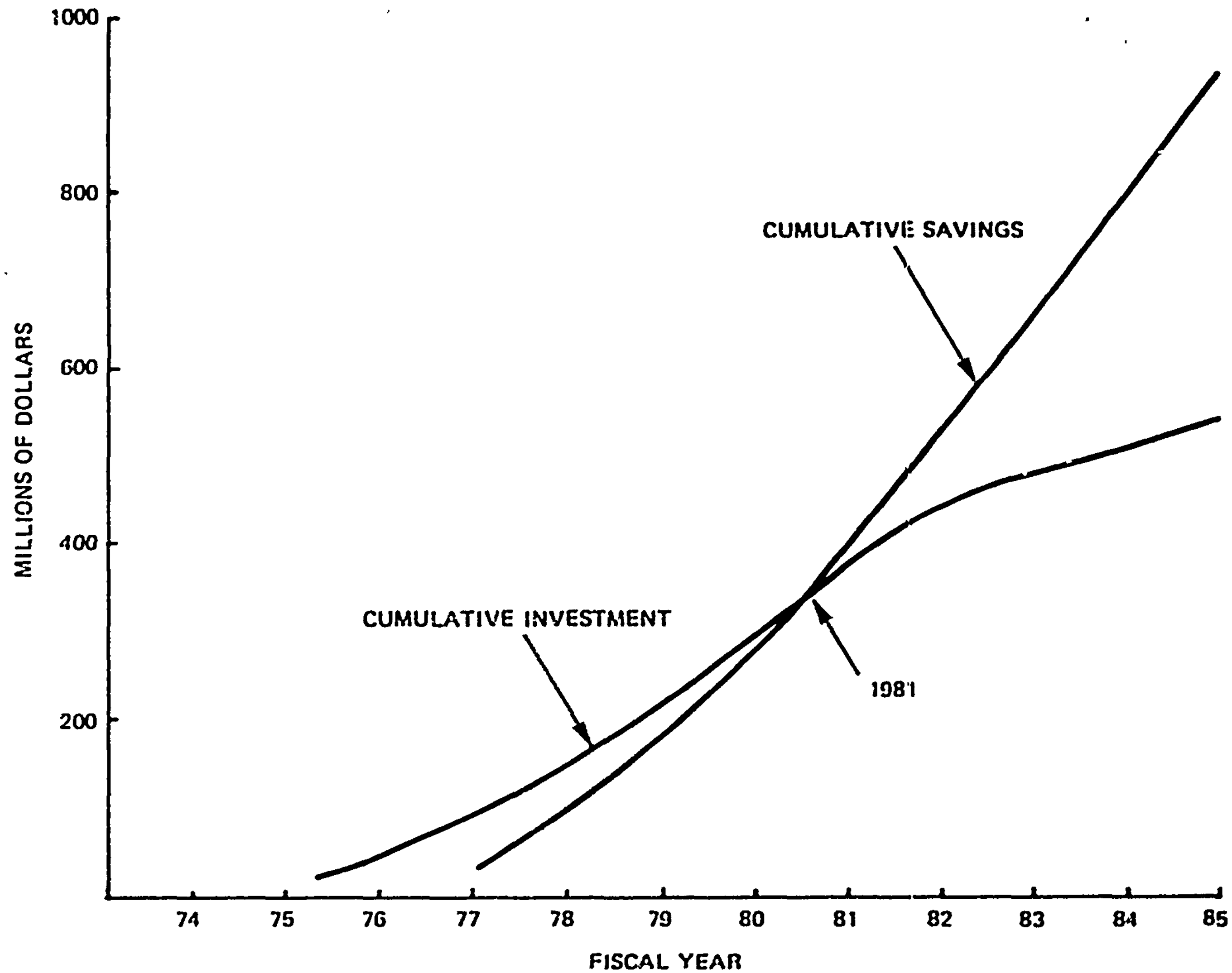


Figure 3-4. NAVY AND MARINE CORPS ENGINEERING PROGRAM INVESTMENT vs SAVINGS

Efforts related to shore facilities energy conservation have been integrated by NAVFAC into one energy engineering program to coordinate all endeavors and objectives under one management. Three major program categories have been developed to logically structure the numerous and highly diversified activities in the overall conservation effort undertaken by NAVFAC and its six Engineering Field Divisions:

- Energy use in existing facilities.
- Capital investment programs.
- Planning, engineering, and designing for new facilities.

A fourth program category, demonstration projects, also under NAVFAC, is discussed in Section 3.4.2.

3.2.2.2 Energy Use in Existing Facilities

This category, of those listed above, includes the broadest range of program activities. However, only the more significant program activities will be examined.

The major objective in this program category is to provide each station Commanding Officer with facilities engineering and technical assistance by using activity conservation surveys. To date, over 250 surveys have been completed and NAVFAC estimated that the annual energy savings is $39.6 million.

The information extracted from the initial activity surveys were very useful in developing projects suitable for the ECIP (see Section 3.2.2.3). However, the initial activity surveys did not touch on all possible areas and a Phase II energy conservation survey program is underway to identify, estimate, and program more complex, higher payoff energy savings projects. So far, 25 Phase II surveys have been completed. The state-of-the-art in energy engineering is developing rapidly and it is probable that subsequent phases of the survey program will be required to facilitate the use of improved techniques and equipment, at least through 1985.

To monitor energy conservation performance, the Defense Energy Information System (DEIS) was initiated in 1974 to measure energy use and to relate current trends to past performance. The DEIS-II report on utility energy use and cost is filed monthly to the Defense Supply Agency (DSA) for about 400 Navy and USMC activities. DEIS-II supplies OSD, CNO, and major claimants with accurate and timely data to use in energy management and to appraise energy conservation performance.

Technical training, to promote effective energy management, is being provided by NAVFAC to managers, engineers, and operators. Four courses have been developed to teach proven energy conservation techniques. The energy management course has been attended by about 300 managers, engineers, and operators in six sessions. The design criteria for new and existing buildings course has, so far, been provided at seven sessions. A correspondence course in plant operation, survey efficiency in utilities operations, is available.

Boiler efficiency programs have been initiated to improve the operating efficiency of the Navy's shore power facility system, which use energy-intensive equipment. In plants using over 5 million Btu, consisting of some 600 boilers at 126 activities, a Boiler Tune-Up (BTU) program has been organized to clean emissions and improve efficiency. The program is 65 percent complete and has achieved annual savings of $2.5 million. In plants using under 5 million Btu, 1500 of a total of 4000 units have been inspected and calibrated, achieving annual savings of $480,000.

In the utilities procurement area, there has been an effort to minimize the impact of rising fuel costs, increaseed cost of capital equipment, and environmental limitations. Rate engineers have been hired to handle the increased workload caused by the numerous energy rate increase cases. This effort will have a potential impact of millions of dollars on the Navy's budget.

Natural gas supply and distribution costs are being monitored to anticipate the effect of future gas curtailments on the Navy's activities. Contracts have been negotiated for the direct purchase of steam from three commercial waste heat boilers. Since this will achieve an estimated fuel savings of 340,000 barrels, several other similar contracts are being considered. This type of negotiated total energy service permits the phase-down of old equipment, decreases plant operating personnel, and reduces costs.

DOD has proposed fuel selection and storage criteria for Navy/USMC heating plants and boilers to save fuel oil, minimize the impact of reduced natural gas supplies and economize on total fuel costs. These criteria apply to modernizing or replacing existing plants, as well as to building new plants. Measures include providing backup storage for fuel oil facilities and alternative fuels for facilities relying solely on natural gas. In addition, there will be conversion to coal and refuse derived fuel when it is economically and environmentally feasible. Surveys of all major fuel burning installations are being conducted by NAVFAC to determine coal burning capability, where, presently, oil and/or natural gas are the primary fuels. To date, fuel oil storage facilities at four of the Navy's bases, which are most vulnerable to energy supply disruption, have been improved.

A memorandum of 24 September 1974 from the Assistant Secretary of Defense, Installations and Logistics (ASD(I&L)) directed that feasibility studies of total or selective (T/S) energy systems be conducted for all major new construction or rehabilitation projects to maximize energy savings. A T/S energy system requires equipment on-site to generate electricity and heat for power, heating, and/or cooling. In a "total" energy plant, electrical loads and heating/cooling loads are balanced so that waste heat, which is normally lost from the power generation cycle, is re-used for heating and cooling. Therefore, an outside power supply is not required. A "selective" energy system generates and balances only enough waste heat to meet heating/cooling needs, and the balance of the required electricity is purchased commercially.

Of the 18 authorized studies included in the FY 1975 to FY 1977 military construction (MCON) programs, 11 have been completed. Today, results indicate the T/S energy system is not economically practical. However, in a memorandum from Assistant Secretary of the Navy, Installations and Logistics (ASN(I&L)) to ASD(I&L), recommendations were made to shift the studies toward analyzing large complexes rather than individual projects in a given MCON program. As a result, a Navy/ERDA Energy Demonstration Project is underway at the Navy's Sewells Point Complex, Norfolk, Virginia to evaluate total energy efficiency and conservation. (See Section 4.4.2.)

As part of the Navy's environmental quality program, NAVFAC is strongly emphasizing energy recovery from solid waste and waste oil. Efforts include feasibility studies, which have been completed at six of the Navy's shore facilities, including refuse boilers planned or in operation at 13 facilities, and refuse recycling surveys underway for all major facilities. A technical guide to evaluate station solid waste programs has been published.

Finally, technical standards and guidelines in the environmental quality program are being developed for state-of-the-art applications to monitor effectiveness and to conduct studies for Navy-wide applications.

3.2.2.3 Energy Conservation Investment Program (ECIP)

Table 3-4 summarizes the program activities in ECIP. The major objective of the ECIP is to modify and improve existing structures and systems involving energy conservation where cost/benefit assessments recommend doing so. A program was directed by a SECDEF PDM, in July 1974, and funding levels are presently set in the Five-Year Defense Plan (FYDP). Criteria used to determine eligible projects for this program include:

- All projects must be to retrofit or modernize existing facilities.
- Projects must have early paybacks (within six years).
- Facilities located overseas will be initially excluded.
- Energy and dollar savings must be documented.
- Major new construction is excluded.
- Major repair/modernization projects can qualify.

Projects that have satisfied these criteria in the FY 1976 and FY 1977 programs include:

- Storm windows and insulation
- Thermostatic control, automatic set-back, remote monitoring
- Power factor improvement
- Plant economizers
- Heat reclamation
- Air curtains
- Central heati[illegible] stem extensions
- Plant consc[illegible]
- Lighting co[illegible]rsions

Table 3-4. PROGRAM ACTIVITY FILE

Energy Conservation Investment Program		
Program Activity	**Description**	**Problem Areas**
1. Energy Conservation Investment Program	A dedicated construction program to retrofit existing facilities for early payback energy savings projects. ECIP includes MCON for active/reserve forces, and improvements to family housing. FYDP: FY 1976–$38.9 million; FY 1977–$52.8 million; FY 1978–$39.2 million; FY 1979 through FY 1982–$213.4 million.	Program criteria too restricted. It should be expanded to include overseas activities, cold iron projects, and fuel conversions. Inadequate O&MN resources at NAVFAC for planning and project development POM 78 issue approved by CNO. FY 1977 apportionment deficiency identified.
2. Self-Amortizing Projects (under $400,000)	Energy projects which exceed station approval authority, but are under $400,000, with 3 year payback, are eligible for funding in this program. Projects are approved on individual case base.	–
3. Regular Military Construction	All new projects in regular MCON must be designed to meet new energy standards to assure optimum energy use. Major new features involve total energy plants, solar energy facilities, and control systems.	Changes in scope or new projects will increase cost estimates. Additional MCON authorization will be required.
4. Family Housing Improvement Program	Retrofit exists for the Navy's family housing for energy conservation.	Funding included in item 1, ECIP.
5. O&MN	Annual funds required for special projects, improvements accomplished at station level maintenance and repair.	Worthwile O&MN energy conservation projects must compete against operational needs for very constrained O&MN funds.
6. GOCO Plants	GOCO plants need OPN/WPN funding for major energy improvements. Conservation actions implemented at plant level through contractors' initiative, with NAVFAC technical assistance.	Lack of funds for energy saving. Capital improvements.

- Total energy systems
- Summer load boilers
- Condensate return systems.

In the management area, NAVFAC acts as program sponsor for the ECIP. Projects evolve from energy conservation surveys by NAVFAC representatives or from the local facilities. The projects flow through the regular shore installation facilities planning and program system (SIFPPS) and are given priority by NAVFAC Headquarters according to payback. NAVFAC sponsors the priority listing, defends individual project engineering to OSD and Office of Management and Budget (OMB), and later furnishes testimony to Congress.

Under the self-amortizing projects program, CNO has initiated a change in urgent minor construction criteria to allow competition for urgent minor funds. Activities planning such projects can submit them without a certificate of urgency, and, if justified technically and economically, project action can begin much earlier, as opposed to waiting for the normal MCON cycle.

Family housing conservation relies heavily on capital investment to achieve positive results. This is because the management program, by necessity, is voluntary. Presently, retrofit projects primarily involve insulation, storm windows, caulking, roofing, and lighting improvements. Participation of the Navy's family housing program in ERDA's solar demonstration program will probably produce significant energy savings.

Little attention has been given to energy conservation in GOCO plants, where it is widely recognized that significant energy savings are available. There have been some attempts by contractors to lower costs. Since DOD has determined that capital improvements to GOCO plants must be supported from appropriations designated for these plants (OPN, WPN, etc.), few, if any, major retrofits have been accomplished. This is because capital improvement funds are lacking in the NAVFAC budget.

From a net energy point of view, the cold iron project saves energy and dollars because of the higher operating efficiency of shore utilities, as compared with shipboard power generation while in port. However, many of the high potential energy conservation projects have been rejected because too narrow a perspective was assumed, that is, only the impact on shore facilities energy usage was examined. Total energy usage by the entire Navy was not studied.

Competition with direct operational support projects has also restrained initiating energy related cold iron projects supported by regular MCON. NAVFAC views such projects as having high payoff potential, and strongly recommends that further consideration and funding support be provided.

A number of construction projects are also in the planning stages for solar energy, total and selective energy applications, geothermal, and new boilers. These projects are primarily demonstration projects, which combine the Navy's and ERDA's funding, and they are discussed in Section 3.2.5 to emphasize special problems and cooperative aspects.

To identify requirements and evaluate as soon as possible the several classes of projects that are described, engineering surveys and analyses are needed in the first stages of the facilities' planning cycle. The necessary resources (manpower and dollars) for this effort are primarily O&MN appropriations. Resources have been included in NAVFAC's FY 1978 POM. However, an apportionment deficiency still exists for FY 1977.

There are energy related improvements, in addition to cold iron and overseas projects, that are not covered in existing programs. They include:

- Back-up fuel storage for shore plants burning natural gas and oil.
- Conversion of shore plants from oil or gas burning to coal burning.
- Major new construction to consolidate and replace inefficient buildings.

These deficiencies have occurred because some projects related to energy self-sufficiency cannot be justified on the basis of dollar savings alone, and funding allocations have prevented including many worthwhile projects.

3.2.2.4 Planning, Engineering, and Designing New Facilities

The objective of this program is to integrate energy policy, standards, and goals into the master planning, engineering, and designing activity of NAVFAC and its Engineering Field Divisions. The plans and specifications for military construction for Navy, Marine Corps, OSD, Air Force, and other agencies are prepared according to NAVFAC's standards and criteria. All energy features of each major project are thoroughly analyzed, including running a computer simulation of various system alternatives. Design engineers incorporate energy savings features in major new construction and rehabilitation projects where it is economically justified. The total construction effort that is affected runs roughly from $600 to $800 million annually, depending on congressional authorization and appropriation.

Energy conservation has been included as a requirement in NAVFAC's master planning function. All new plans, and revisions to existing master plans, must contain a separate analysis of energy planning considerations.

As a basis for evaluating and weighing life-cycle cost analyses of all facilities projects, planning factors that consider projected energy costs are continually assessed. An on-going effort will determine and validate near-term and long-term energy and energy-related costs. The most recent study of this subject was completed in early 1976. Energy and commercial utility situations will be further assessed as they develop.

Specific and representative energy-related tasks in facilities planning design and engineering have been completed recently. Others have just been initiated. The following list is not all inclusive:

Completed Tasks

- Energy design criteria – "Technical Guidelines for Energy Conservation."
- Manual entitled "Selection, Application, and Cost Analysis of Control Building Automation Systems."
- "Criteria for Solar Energy for Space Heating and Domestic Water Heating."
- "Criteria for More Economic and Better Insulated Underground Heat Distribution Systems."
- "Energy Conservation in New and Rehabilitated Buildings by Computer Simulation of Building Energy Consuming Systems."
- "Energy Conservation Lighting Criteria," which was issued by NAVFAC.

Tasks Underway

- Upgrading "Mechanical Guide Specifications and Referenced Equipment Specifications for Better Energy Utilizations."
- "Boiler Construction Criteria–Improved Design and Efficiency."
- Modernization of definitive drawings and specifications for control steam heating plants."
- Specifications for convertible (coal-oil-gas) packaged boilers.
- Update and revise shore activity master plans to incorporate energy features, utilities planning, and total energy concepts.
- Validate and revise guidelines for economic analyses of facilities projects.

This program is on-going and needs "level of effort" funding in NAVFAC. Rapidly evolving technology also requires uniform guidelines for NAVFAC and facilities field engineers.

3.2.3 The Navy's Housing Energy Conservation

The Navy's family housing uses about 10 percent of all utilities consumed by the entire Navy's shore facilities. These utility costs account for about 55 percent of the total family housing O&MN budget.

In FY 1975, the latest full fiscal year for which data is available, the scope of the Navy's housing activity, as to cost of utilities and number of units supported, was:

	Total Cost (Millions)	Cost/Unit/ Year	Number of Units
Navy	$53.4	$731	73,011
Marine	10.3	$547	18,799
Total	$63.7	$639	91,810

Estimated FY 1976 utility costs for the Navy's housing were about one-third higher than FY 1975 costs for 3,541 additional units.

The energy portion of the Navy's housing utility costs for FY 1975 is divided into:

Electricity	68.5 percent
Gas	13.2 percent
Fuel oil	9.3 percent
Other	9.0 percent

FY 1976 data indicates percentage increase in cost for electricity and decreased percentage costs for gas, fuel oil, and other.

The Navy's goal for housing conservation is to achieve a minimum 15 percent reduction in utilities consumption over the baseline year of FY 1973. The guidelines for this program include:

- The Navy will not impose on its housing occupants more stringent or restrictive energy conservation measures than those imposed by the private community.
- The Navy conservation program will be entirely voluntary, except where financial limitations make some mandatory reductions necessary.
- NAVFAC's responsibility is to monitor the energy conservation program and implement energy conservation projects.

The Navy's housing conservation programs are divided into three general categories: personnel; technical; and management and policy.

Personnel programs are public affairs and education programs that encourage housing occupants to participate in conservation programs. They include:

- The Navy's Family Housing Energy Conservation Handbook, which was published by NAVFAC in March 1974. It identifies the role of the Commanding Officer, Public Works Officer, Energy/Utilities Conservation Officer, Housing Manager, and occupant in the energy conservation program. It has a handy detachable pamphlet that is given to tenants, and contains many good energy conservation tips.
- The FEA pamphlet, "Tips for Energy Savers," is distributed to all housing occupants.
- NAVFAC publishes a *Housing Newsletter* and the first issue was devoted to energy conservation.
- All NAVFAC activity and housing publications continue to stress energy conservation.
- The Navy will encourage participation in community associations in energy conservation programs.

The many and varied technical programs include:

- Installing water/energy saving shower heads. NAVFAC expects that an anticipated 65 percent reduction in water, energy, and sewage costs will cause a payback in the procurement and installation costs in 3 to 4 months.

- Insulating buildings by weather stripping, caulking, installing storm windows and doors, and upgrading or installing attic and wall insulation. This effort has been concentrated in the north and northeast United States.
- Testing solar energy use in family housing. This involves heating, cooling, and hot water systems.
- Using utility conservation teams to make comprehensive energy conservation surveys of activities. These teams look for many routine ns that contribute to energy conservation such as repairing steam and other leaks, adjusting boilers, closing off unused areas, and using thermostatically controlled dampers in individual rooms.

Implementing management and policy programs would require major management and/or legislative changes in the Navy's housing program. In many cases, these programs tend to be antipersonnel and antimorale. They include proposed programs such as installing meters on the Navy's housing electrical systems and charging fair market rental (FMR).

Rapidly escalating utilities costs are causing funding shortfalls and the situation will probably get worse. Because funding for family housing is a separate appropriation, there are no other funds available to supplement the appropriation. Therefore, as costs of housing utilities rise, housing maintenance funds must be used to offset the increase. This has caused the maintenance backlog to increase dramatically.

Under the present system, utilities are provided to military housing occupants without charge as part of entitled compensation. There is no incentive for the occupant to conserve energy until he can see or is shown that the [illegible] of funds caused by rising utilities costs are affecting the maintenance of his quarters.

Thus, this situation has led to proposals to alleviate this basic problem. These include:

- Dividing BAQ payments into two parts: shelter and utilities. If utilities allotments are exceeded, the housing occupant would pay the difference. This would require installing meters in Navy housing, which would be a costly, and, in some instances, a very difficult project. The electrical systems in most housing areas were not designed to accommodate meters. The probable cost for installing meters is estimated between \$60 million and \$100 million. To this, of course, would be added the cost of reading meters and the accounting system necessary to support the project. These costs would most likely be passed onto the occupant. HUD experience in its public housing program shows that a reduction of 20 to 30 percent of current housing energy consumption is possible by installing individual meters, with the occupants responsible for paying what they use.
- Charging occupants FMR, or a high percentage thereof. This has been discussed in various OSD-OMB proposals.

Both proposals would require that Congress pass legislation to change the present laws. Both proposals would transfer additional utilities costs from the government to the household occupant and, thus, decrease military fringe benefits. It is probable that such measures will be opposed by those responsible for the Navy's morale.

3.2.4 The Navy's Energy Conservation Research and Development

3.2.4.1 Shipboard Energy Conservation Research and Development

Only conservation will have a near-term impact on the problems of reducing the cost and increasing available energy sources. Consequently, it has received immediate and continuing attention by the Navy Energy Research and Development Office.

The primary rationale of the Navy's energy conservation research and development is to evolve and implement new technologies or operational practices that will reduce energy consumption, and to develop new propulsion and auxiliary machinery that is more efficient than the systems now used.

In keeping with the policy recommendations of the Defense Energy Task Group (DETG), the Navy Energy Research and Development Office (MAT-03Z), has concentrated on energy conservation on ships and on shore installations. The leading DOD agency for aircraft fuel conservation is the Air Force.

The Navy's research and development for shipboard energy conservation is to improve the efficiency of energy use by modifying equipment, improving operating procedures, developing hull maintenance technology to reduce frictional drag, and using waste-heat recovery systems. New, advanced machinery concepts are being examined for suitable application to the future fleet.

Research leading to the improved efficiency of shipboard machinery components and systems primarily involves developing more efficient ship propulsion, combined chemical dash power, and nuclear cruise power systems, and includes investigating the effects of corrosion, scaling, and sludging on shipboard power systems, metallurgical and mechanical behavior of thermostructural alloys, properties of ceramics for high temperature heat exchangers, wear control in the Navy's mechanical equipment, and liquid metal magnetohydrodynamic (MHD) generators.

A hull cleaning research and development effort will develop advanced techniques for the waterborne removal of marine fouling, with particular emphasis on reducing the labor-intesive character of current cleaning methods.

A hull coating research and development effort will develop advanced antifouling coatings. Present laboratory developing, testing, and evaluating organometallic polymer (OMP) paints will be continued under this task.

Major energy savings can be achieved by an optimization of shipboard machinery task, which would first identify energy-intensive machinery systems and operational procedures aboard major ship classes, and then modify equipment and procedures. Initial estimates of potential fuel savings that could be achieved by shipboard machinery system optimization are about 10 percent.

Conservation through operator training can be accomplished by encouraging responsible operator personnel to avoid energy-wasting practices. To promote awareness of the impact of individual energy conservation on ship fuel consumption, a pocket manual entitled "Conservation of Energy Aboard Ship" was prepared, published, and distributed to the entire fleet. This manual, which includes factual information on energy usage patterns within the fleet and stresses the importance of responsible operator action in affecting energy conservation measures, will be updated periodically.

The advanced ship components project will provide for designing, fabricating, testing, evaluating, and qualifying machinery systems and components that potentially offer reduced fuel consumption through improved efficiency but, at the same time, not reduce the effectiveness and mission capability of future (nonnuclear) ships and craft. Examples of projects to be pursued in this area include: installing stack gas analyzers on steam-powered ships; investigating mechanisms that contribute to fouling of heat exchangers; and assessing heat exchanger requirements necessary for implementing waste heat recovery systems.

The Navy Energy Research and Development Office is primarily responsible for supplying direction and policy for overall shipboard energy conservation research and development and for coordinating pertinent research and development programs being conducted by NAVSEA and the Navy's laboratories. The Navy laboratory performing this work is the David Taylor Naval Ship Research and Development Center located at Carderock, Maryland. Additional research is being performed by the Office of Naval Research and the Naval Research Laboratory.

3.2.4.2 Shore Facilities Energy Conservation Research and Development

During FY 1976, the Navy's shore facilities consumed energy equivalent to 36 million barrels of oil. About 50 percent of this was used for heating, ventilating, and air conditioning (HVAC), totaling about $185 million. Although this is a 14.1 percent reduction in total energy consumed by shore facilities (less ground support vehicles) relative to the 1973 base year figures, total energy costs more than doubled during this three-year period. This indicates the importance of maintaining and expanding an effective energy conservation research and development program. The effectiveness of energy conservation is reflected in the 14.1 percent reduction, which resulted in a $56 million saving.

The objective of the shore facilities energy conservation research and development program is to reduce the consumption and total energy cost of shore activities by developing and implementing new technologies or using operational practices that will reduce energy consumption. This will be achieved by eliminating losses incurred without losing effectiveness, and developing new auxiliary power generation heating and cooling equipment that is more efficient. The specific objective is to reduce energy consumption by 15 percent, compared with FY 1973.

The energy conservation concepts that NAVFAC is investigating include: evaluating new building methods and materials using computer analysis and selected tests; assessing total energy systems and total energy communities for specific application of the Navy and defining system selection procedures; investigating potential improvements in industrial power efficiency and steam generation cycles; and evaluating infrared scanning techniques to assist field conservation efforts. Table 3-5 lists research and development activities to reduce energy usage in the Navy's shore facilities.

The Navy Energy Research and Development Office is primarily responsible for providing overall direction and policy in shore facilities energy conservation research and development and for coordinating the efforts of the research and development programs being conducted by the Navy's laboratories.

NAVFAC and the Civil Engineering Laboratory (CEL) are responsible for energy conservation research and development programs for the Navy's shore facilities. The Energy Program Office, located at CEL, is building an energy technology base tailored to the Navy's needs by assimilating advances in the national energy program and by evaluating hardware at the CEL and then transferring that technology to field activities.

3.2.5 The Navy's Energy Incentives Awards Program and Energy Conservation

The federal government employees incentive awards program was established to improve government operations and acknowledge the achievements of employees through incentive awards. The awards are designed to:

- Encourage employees to improve the efficiency and economy of government operations.
- Acknowledge and reward employees, individually or in groups, for their suggestions, inventions, superior achievements, improvements, or other personal efforts that contribute to the efficiency and economy of government operations.
- Acknowledge and reward employees, individually or in groups, who perform special acts or services in the public interest in connection with or related to their employment.

Policy for incentive awards in the Department of the Navy complements federal policy. Consistent with federal policy, the Navy's incentive awards program has been established to encourage maximum participation of its employees in improving operations of the Department of the Navy and the government. This program provides, to individuals and groups, monetary and/or honorary awards for civilian employee contributions, which benefit the government.

The Secretary of the Navy has delegated responsibility for the overall administration of the program to the Director of Civilian Manpower Management, and as such, he

Table 3-5. SHORE FACILITIES ENERGY CONSERVATION RESEARCH AND DEVELOPMENT PROGRAM ACTIVITIES

Program Activity	Description
1. Energy Conservation Handbook	There have been consultations with Air Force and Army on an energy conservation handbook. A review of the outline for the handbook was held at the National Bureau of Standards (NBS), Washington, D.C. Coordination is being continued on a products catalog that wil' e eventually included in energy conservation handbooks (retrofit . id new construction).
2. Total Energy Systems Study	A broad assessment of the Navy's current total energy use and future projections of total energy use has been published. It includes specifications for total energy systems for Great Lakes Naval Training Center (NTC) and Pensacola Naval Air Reserve Facility (NARF). Guidelines for selecting the Navy's total energy systems are being drafted.
3. Lighting Systems Experiments	An industry survey of lighting systems has been completed, and promising concepts have been selected. A material request has been submitted for the required light sensing and control equipment. One commercial system and two systems developed at CEL have been tested and the results are being analyzed.
4. Improved Building Insulation and Installation Techniques	Several wall insulating materials have been selected for computer analysis. Urea formaldehyde foam has been injected into the walls of a house and it is being tested for effectiveness. Test results data are being analyzed.
5. Improved Industrial Power and Steam Generation Cycles	Analysis of the organic Rankine cycle using waste heat from diesel engine exhaust shows that it can be cost-effectively applied to diesel-electric generation plants.
6. Heating and Cooling Loads Computer Simulation	Under the sponsorship of ERDA, a joint federal activities effort is underway to improve the capability, simplify the input, and reduce the run-time of the developmental version of the Loads and Systems Simulation (LASS) computer program. The LASS program was developed by the U.S. Army CERL by combining the NBS Load Determination (NBSLD) program and NASA's National Energy Cost Analysis Program (NECAP). LASS is designed to simulate building thermal loads and HVAC system performance and is currently available on the Livermore Berkeley Laboratory CDC computer system. The NBSLD is available at the Facilities Systems Office (FACSO).
7. Infrared Detection Energy Losses	The Probeye IR scanner and the AGA 750 IR system have been selected for testing. Preliminary tests indicate the Probeye IR scanner may prove to be useful and economical The AGA 750 IR system has been found satisfactory as a field inspection tool. An aerial IR survey of Sewells Point is expected to produce a useful evaluation of aerial techniques.
8. Absorption Air Conditioning Using Solar Energy Sources	A review of the literature on solar air conditioning is about 85 percent complete. A work statement for a contract to perform a study of solar air conditioning has been prepared.
9. Solar/Night Radiation Augmented Heat Pump Analysis and Design	There has been considerable effort over the past 30 years by individuals throughout the world to design a system of this type. This is presently being pursued by ERDA (Office of Conservation) and the Electric Power Research Institute. Generally, the systems that have been tested have succeeded in raising the seasonal performance factor. This is a seasonal coefficient of performance term and a measure of energy savings.
10. Advanced Energy Conservation Programs	Studies of advanced energy conservation systems will focus on total/selective energy applications, low-temperature heat recovery, and new developments in storage and power generation. Some of these technologies could possibly reduce the logistical burden for fuels at advanced and remote bases.

establishes policy, issues standards, grants exceptions, disseminates contributions to DOD and other federal agencies, and consolidates required reports. Also, the Navy's Incentive Awards Board has been created to assist in attaining program objectives.

There are no plans to establish a special incentive awards program for the energy area, although energy conservation awards have been granted via the Navy's incentive awards program. Traditionally, special programs have not been created for individual areas, but, rather, these areas have received special emphasis because of the publicity within the existing incentive awards program. There are no centrally located records that reflect in simple format the effect or participation by government employees in energy conservation. The question of creating a special program should probably be resolved through a study to determine the costs and potential benefits of such a program. Presently, it appears that the added administration and reporting involved in a special program is not warranted, and the basic incentive awards program is sufficient for the Navy's needs.

3.2.6 Training Devices (Simulators)

3.2.6.1 Aviation Training Devices

Because of advancing technology, new and more sophisticated simulators have been developed recently that can very closely simulate aircraft flight parameters, and, consequently, can contribute significantly to reducing aircraft flight hours thereby reducing fuel expenditures and overall training costs. Maximum use of simulators is being encouraged.

In FY 1976, the Navy simulation program resulted in POL savings of 69.3 million gallons valued at $47.7 million. The simulator energy conservation program continues to significantly expand as new simulators are delivered and additional training hours are substituted for flight hours.

The Deputy Chief of Naval Operations (Air Warfare) and the Director of the Manpower and Training Division, in coordination with Marine Corps Headquarters, are responsible for all the Navy's and Marine Corps' flight training device matters. The Aviation Training Device Requirements Branch manages all simulator and other training materiel programs for aviation. This office establishes requirements for flight training equipment, approves training device plans and programs, and prepares the simulator equipment budget, which is considered by Congress.

DOD program efforts to achieve a 25 percent reduction in flying hours and a concomitant savings of energy resources, with increased use of simulators by 1981, has been consistently supported by Congress and the Navy. However, presently funded simulator programs will only give a 13.4 percent substitution rate by 1981. This projected shortfall is because of acquisition and support funding deficiencies, training effectiveness considerations, and manpower constraints.

The anticipated fuel savings for the next five years are:

	POL Gallons Saved
FY 1978	72,900,000
FY 1979	83,000,000
FY 1980	85,500,000
FY 1981	88,100,000 (peak)
FY 1982	84,900,000

The quality of the flying forces must continue to be the same or better than before the use of simulators began. Although saving energy resources is important, the quality of the flying forces has a higher priority. Saving energy resources cannot become the principal objective of the simulator program. The primary purpose of the aviation simulator program is to improve training by increasing overall training effectivess. The purpose of all flying that is considered to be "substitutable" is training and any neglect by planners in considering this purpose as primary will ultimately have a negative impact on fleet readiness. Additionally, if training effectiveness is not considered foremost, much of the short-term training obtained through simulation may have to be duplicated, in the long-run, in flight. Major problem areas encountered in using simulators in supporting the energy savings program include: lack of user acceptance of simulators; maintenance costs; personnel requirements; overall cost effectiveness considerations; and, in some cases, a lack of overall energy savings effectiveness.

3.2.6.2 Ship Training Devices

Ship simulators have been used long before the present energy crisis. They range from large cumbersome analog systems to sophisticated modern digital computer based systems. They are designed for specific purposes such as shipboard antisubmarine warfare (ASW) and antiair warfare (AAW) training, pilot and navigation training, ASW tactical training and war-gaming. Representative systems include: NEWS-WARS at Naval War College, Newport, Rhode Island; 20A61 at the Education and Training Center, Newport, Rhode Island; 14A2 ASW Ship Simulator at various locations; 14A6 ASW Tactical Trainer at Norfolk, Virginia and San Diego, California; and TACDEW AAW Trainer at Dam Neck, New Jersey and Point Loma, California. Although these trainers and simulators were not developed for energy conservation, they contribute significantly to energy savings.

The original DETG recognized the correlation between energy conservation (as expressed in OPTEMPO) and readiness. One DETG recommendation was that "the Joint Chiefs of Staff should emphasize the need for energy conservation in tactical operations and should develop a methodology to quantify the impact of fuel shortages on readiness." Today, budget restrictions have hampered fleet commanders and fuel allotments to the fleets have been reduced. This has resulted in reduced OPTEMPO expressed in operating days per quarter. This deficiency can be made up, in part, by using simulators.

There is no comprehensive plan for using simulators for energy conservation. Some fragmented efforts at the fleet and type commander levels have been, at least, partially successful in attempting to fill the training and readiness gap caused by the reduced underway time available. However, before any effective plan can be developed, it will be necessary to answer certain questions:

a. What OPTEMPO is necessary to obtain optimum readiness? Acceptable readiness? (These will require defining readiness in some measurable terms.)

b. What is the energy intensiveness of the various types of intraship and intership exercises conducted by the Navy's units?

c. What portion of the Navy's ship training could be conducted on simulators without reducing readiness? What are the energy savings and cost tradeoffs of using simulators?

3.3 SYNTHETIC FUELS STRATEGY

3.3.1 Synthetic Fuels Research and Development

ERDA is providing the primary impetus for developing a synthetic fuels industry. In evolving this industry, based on the nation's natural resources of shale, coal, and tar sands, many programs have been initiated that could be commercially acceptable. Since commercialization is a major goal of the national synthetic fuels program, DOD and the Navy's support of long-range demonstration and production planning programs should prove to be directly beneficial to the Navy.

The major objective of the Navy's synthetic fuels research and development program is to test and evaluate refined fuels from oil shale, tar sands, and coal and test modified machinery to prepare for the eventual use of commercial synthetic fuels.

The Navy Energy Research and Development Office has been assigned DOD responsibility for providing overall direction and policy for the synthetic fuels research and development program and for coordinating the efforts of research and development programs being conducted in each of the Navy's SYSCOMs and by the Navy's laboratories. Each Navy SYSCOM (NAVAIR, NAVFAC, and NAVSEA) is responsible for structuring research and development programs in response to guidelines provided by MAT 03Z. The Department of the Navy is presently developing a long-range plan for procuring test quantities of synthetic fuels in coordination with the DOD, Air Force, Army, and ERDA.

Producing additional military fuels (JP-4, JP-5/Jet-A, DFM/DF-2) from oil shale derived crude is the primary reason for testing synthetic fuels. The SYSCOMs will conduct the small-scale and full-scale tests and operational trials to evaluate synthetic fuels that would be compatible with existing hardware systems. They include:

- Aircraft fuel characterization analysis
- Synthetic fuels laboratory testing
- Small-scale aircraft engine testing

- Full-scale aircraft engine testing
- Small-scale tests for utility boilers
- Full-scale tests for utility boilers
- Small-scale tests for ships
- Full-scale land-based tests of synthetic fuels for ships
- Sea-going flight tests of synthetic fuels
- Endurance testing of synthetic utility fuels
- Sea trials of synthetic fuels for Navy ships.

3.4 ENERGY SELF-SUFFICIENCY STRATEGY

3.4.1 Energy Self-Sufficiency Research and Development

Developing and applying energy self-sufficiency technology within the Navy's research and development establishment will decrease dependence on foreign petroleum supplies, especially at remote locations where transport costs are higher and where supply lines are more susceptible to interruption. Throughout this effort, there will be an attempt to coordinate with the Army and Air Force and to closely monitor on-going research and development efforts in the civilian sector, particularly in ERDA.

The objective of this strategy is to demonstrate technical feasibility and to collect cost and performance data for equipment, which will help reduce dependence on conventional energy supplies.

Solar, wind, geothermal, advanced energy conversion, and solid- and liquid-waste recovery technologies will be evaluated. The objective in assessing solar technology will be to test equipment that may become available to the Navy. Using central solar-electric plants could displace significant quantities of purchased fuel and electric power at the Navy's facilities. However, the economics of solar-electric power generation is currently estimated by ERDA to be competitive only with conventional systems having capacities between 10 and 500 megawatts, which is well above the demand at most of the Navy's bases.

A substantial number of the Navy's shore facilities have average wind speeds that are sufficiently high for wind generators to produce electrical power. This would be cost competitive with conventional power plants. Although the economic payback periods are typically 10 to 20 years, wind generators could supply 10 percent of the required total shore facility energy demand. Wind generators are becoming available through ERDA-sponsored programs and through commercial development.

A limited number of the Navy's bases are located near known geothermal resource areas (KGRA). Geothermal steam or hot water may generate electrical power at low cost, while simultaneously heating buildings. Geothermal energy, when available, supplies a stable power source. National research and development emphasizes designing systems that can withstand the corrosive elements found in most geothermal heat sources. An assessment of geothermal resource development techniques is being conducted by the Naval Weapons Center at China Lake, California.

Solid-waste recovery systems and burning solid refuse-derived fuel (RDF) in conventional boilers are options available to the Navy to reduce consumption of fossil fuels at its shore facilities. An analysis of packaged heat recovery incinerators indicates that payback periods of less than 10 years can be expected, including operating costs, capital investment, and allowing decreased disposal cost. Combined liquid- and solid-waste processes under investigation at CEL can make a significant contribution to the energy self-sufficiency of the Navy's bases. These closed-cycle processes would be applicable where air pollution control for conventional incineration is prohibitive. The Navy has one solid-waste fueled plant in operation in Norfolk, Virginia and another is nearing completion. The steam generated is used aboard berthed ships. Studies have been initiated to investigate using refuse as a fuel for other Navy installations.

The Navy Energy Research and Development Office is primarily responsible for overall direction and coordination of the NAVFAC effort in energy self-sufficiency research and development. The Navy Energy Program Office at CEL, in Port Hueneme, California, will head the research and development by conducting research at CEL and then transferring the technology to other facilities. The Navy Energy Research and Development Plan gives a detailed update of the status of self-sufficiency research and development projects that includes planned funding. NAVFAC energy self-sufficiency research and development includes:

- Applying solar heating concepts
- Solar advanced energy utilization test bed (AEUTB)
- Solar collector and thermal storage
- Photovoltaic equipment for advanced bases
- Central solar-electric power generation
- Solar desalination applications
- 5- to 10-kw wind generators
- Small-scale vertical axis wind machine
- Site selection for 100 to 1500 kw wind generators
- Handbook—wind power generators
- Developing known geothermal resource areas (KGRA)
- Open-cycle solar electric-turbine generator
- Low-temperature heat-recovery power system
- Advanced power generators for advanced bases
- Packaged heat-recovery incinerators
- Analyzing combined solid- and liquid-waste processes
- Refuse-derived fuel (RDF) processes.

3.4.2 Navy and Federal Agency Energy Demonstration Projects

A Memorandum of Understanding between ERDA and DOD is being prepared as a basis to cooperate in national energy and energy-related projects. The purpose of the memorandum is to define the rationale for a cooperative effort between ERDA and DOD involving nonnuclear energy sources, and to delineate the policies and procedures for effecting DOD collaboration in the ERDA research and development program. DOD, as the single largest federal agency user of energy, has a vital interest in the results of ERDA's energy research and development, including programs involving fuel conservation, developing domestic synthetic fuels, and renewable energy sources. There is also DOD interest in certain FEA programs.

At the NAVFAC level, there is particular interest in cooperative programs on conservation technologies, solar heating and cooling, geothermal energy, and direct coal utilization.

The Navy and ERDA have agreed to carry out a major study of energy use and energy conservation at the Sewells Point Naval Complex, Norfolk, Virginia. Activities will include NAVSTA, NAS, NSC, AFSC, family housing areas, PWC, and all facilities in the area. The study will relate energy uses to energy sources and distribution and identify more efficient methods of generating, converting, and distributing energy. Alternative methods will be compared on the basis of relative economy and payback. The study will result in recommendations for near-term fixes and longer-term research and development demonstrations.

As part of a program to develop fluidized-bed combustion techniques in industrial utilities applications, ERDA is jointly sponsoring several demonstration projects with major manufacturers in the boiler industry. The fluidized-bed boiler, a more efficient boiler unit, can burn low-grade fuels with minimum stain emissions. The Navy is interested in using high-sulfur coal that is more readily available and less costly. NAVFAC is working with ERDA and industry to develop a demonstration project at the Public Works Center, Great Lakes, Illinois. The project would require roughly five years for planning, development, constructing, and testing. The results eventually would have wide application at several of the Navy's large plants, other industrial activities in DOD, and the private sector.

After the Solar Heating and Demonstration Act was passed, DOD and ERDA decided to cooperate in a project to outfit 50 family housing units with solar collectors for environmental heating and domestic hot water. Although the Navy is responsible for 16 of these units, it is the control procurement agent for all the Services. The 16 units are:

- Retrofit
  - New London, Connecticut 2
  - Twenty-Nine Palms, California 3

- New Construction
  - Charleston, South Carolina 4
  - New Orleans, Louisiana 4
  - San Diego, California 3

Several other specific projects have been initiated. At the Naval Ammunition Depot, Hawthorne, Nevada, a duplex house has been outfitted with solar collectors for heating and they are being tested and evaluated. At Cecil Field, the FY 1975 military construction project for a new dental clinic includes solar collectors and storage for domestic hot water. The Navy's share of additional housing units in the ERDA approved budget is:

FY 1977 – 320 units (heating and hot water)
FY 1978 – 130 units (heating and cooling)
FY 1979 – 200 units (heating and cooling).

Recently, NAVFAC published a solar design handbook for shore facilities to provide engineers working at the installation level with technical guidelines for additional projects. Solar collectors for hot water, heating, and air conditioning are now being considered for FY 1977 MCON at the Navy Regional Medical Clinic in Orlando, Florida, and the Naval Weapons Center, China Lake, California. Two other FY 1977 MCON programs include solar and/or hot water at Naval Magazine Lualualei, Hawaii and Naval Submarine Training Center, New London, Connecticut.

NAVFAC is evaluating the feasibility of a joint Navy/ERDA geothermal energy power plant at NAVSTA, Adak, Alaska. Several potential contractors have expressed an interest in constructing a plant and providing electricity to the Navy if the heat source can be proven. USGS is performing geological investigations to determine the highest potential areas and field magnitude. ERDA is also conducting drilling operations at NWS, China Lake to identify hot rock formations.

Demonstration projects are generally funded by ERDA or Navy research and development sources. Work is done by contractors or consultants, depending on the nature of the product and stage of development. NAVFAC administers and coordinates this overall effort.

3.5 ENERGY DISTRIBUTION AND ALLOCATION

3.5.1 Fuel Management System and Prepositioned War Reserve Materiel Requirements (PWRMR) for Bulk POL Products

The systems that supply bulk petroleum products to the Navy and Marine Corps include:

a. Underway replenishment system, which supplies ship and aircraft bulk fuels to the fleet. This is composed of USN oilers and Military Sealift Command (MSC) TAO fleet support oilers. These ships are all under fleet command.

b. DOD terminal system, which supplies wartime stocks to satisfy PWRMR and peacetime operating stocks. Although the terminals are under varied control, the product is normally owned by the Defense Fuel Supply Center.

c. At-sea transportation system, which transfers POL from commercial production facilities to designated storage sites.

d. Transportation system, which supplies CONUS terminals and bases.

e. Fuel management system, which procures bulk petroleum products and manages the above components.

The worldwide DOD fuel management system, including procurement, has been assigned to the DFSC of the Defense Supply Agency (DSA). The MSC furnishes the TAOs, which are under fleet command, in the same manner as the USN AOs. The MSC also functions as the waterborne fuel transportation agent.

The PWRMR program, terminal system, management system, and other facets of the Navy's distribution and allocation strategy are described in Section 4.0.

3.5.2 Modernizing the Navy's POL Facilities

In April 1975, ASD(I&L) released a memorandum emphasizing the need for sustained programs by DOD components to schedule the repair and maintenance of worldwide bulk petroleum storage facilities to assure military readiness. Specifically, ASD(I&L) directed that a review of deficiencies and operating support requirements be initiated, and that corrective action programs be submitted through the POM process. The Navy Petroleum Office (NAVPETOFF) developed a POM package for all Navy storage, pursuant to this objective, and initiated a POM 78 Issue Paper concerning the needs of NAVSUP activities. The NAVPETOFF paper listed all known deficiencies and itemized NAVSUP activities by project, location, and type of funding required. Detailed requirements of facilities under the cognizance of fleet, force, and area commanders are under their respective purviews. The POM 78 Issue Paper, submitted by NAVSUP, poses several alternatives for modernizing the Navy's POL and the cost of each alternative. This comprehensive paper cites deficiencies in pollution abatement and control facilities at bulk POL terminals. Preparing and revising projects by field activities is being pursued in conjunction with the programming effort.

The modernization program will probably achieve maximum military readiness of POL distribution facilities, including increased operational efficiency and reduced likelihood of major oil spills. A growing emphasis on POL facilities has been expressed at the OSD level because of the national energy crisis and the probable need for energy independence following the Arab oil embargo. Lack of funds for major maintenance of the terminals has restricted the full capability to perform at a time when energy needs are critical.

The Navy Supply Systems Command is responsible for constructing, maintaining, and operating the Navy's bulk petroleum terminal facilities in CONUS and Hawaii.

CINCPACFLT, CINCLANTFLT, and CINCUSNAVEUR are responsible for facilities in their respective areas. NAVPETOFF supplies technical assistance to NAVSUP and the CINC's with regard to facility construction, maintenance, and operation. It also furnishes technical advice and assistance concerning fuel and lubricant quality control and coordinates worldwide Navy POL consumption requirements and reserve stock levels assigned to CONUS bulk terminals.

The Navy's policy is to maintain POL facilities in full operational condition at all times to maximize military readiness, modernize facilities, where applicable, maximize responsiveness to fleet operational needs, and minimize risks of environmental pollution. The Navy stores about 46 million barrels of bulk fuel at deepwater terminals around the world. Of this total, NAVSUP is responsible for operating and maintaining nine major terminals with a capacity of 21 million barrels. The NAVSUP portion of the worldwide terminal system costs $10 million to operate annually and has a maintenance backlog of $38 million. The modernization and pollution abatement project backlog stands at $77 million. About 50 percent of the total capacity is located on U.S. soil, and there is a major emphasis in modernizing U.S. bulk terminals.

The full storage capacity at several locations cannot be used because of required tank repairs. Some piers cannot be used for fueling the Navy's ships in heavy weather because of structural deterioration. For example, fuel piers at Point Molate, California, and Manchester, Washington, require extensive repairs estimated at $10 million. Using the Point Molate pier is restricted to barge loadings except in an emergency. The Manchester pier cannot be used in a high wind by the two AOE's homeported in the area. The Navy's largest fuel facility at Pearl Harbor has about a 1-million barrel fuel storage capacity in the strategic Red Hill complex, which is not useable because of leaking tanks. The fleet conversion from black oil to clean fuel has created a need for greater storage ashore. Old tankage cannot be converted to clean product storage without expensive modifications.

Presently, program strategy involves rehabilitating existing POL storage facilities, within practical budget limitations, and evaluating future usefulness of those facilities. The rehabilitation program is necessary to achieve full readiness of the Navy's operating forces. The implications of strategic positioning in marginally reliable foreign locations must be considered when constructing additional capacity or in determining which facilities receive priority for repair or replacement. Emergency funding of critical items in the repair program may be required in some instances.

The POM 78 Issue Paper describes four alternatives for modernizing POL facilities:

a. Continue *status quo* (with 4 percent per year of capacity going out of service).

b. Repair by complete *replacement*.

c. Obtain increased funding for POL facility *rehabilitation* to extend useful life of existing tankage.

d. *Lease* required storage space as capacity disappears.

A status quo program would allow facilities to deteriorate further. A level funded construction program to replace facilities will take 25 years and cost over $440 million

(1976 dollars). A five-year rehabilitation plan will extend the useful life, but not replace existing facilities, and will cost $50.9 million. Leasing facilities, to cover required capacity going out of service, will cost $715.0 million over a 25-year period (FY 1976 dollars). Thus, the preferred alternative is to rehabilitate existing storage facilities.

The preferred alternative would increase in-house maintenance capability, gradually reduce the maintenance backlog over the next five years, and add some storage. After five years, NAVSUP storage will be in good condition and will require minimum maintenance for the next 20 years. Additional storage will be considered after receiving further guidelines from OSD levels. The MCON funding includes $14.5 million for rehabilitating Red Hill POL terminal in Hawaii and $5.1 million for replacing the Manchester fuel pier in Puget Sound. These two locations are the most critical areas to rehabilitate in FY 1978.

POL facilities on foreign soil are also deteriorating rapidly. If the deterioration of vital strategic petroleum storage facilities continues, a reduction in military readiness to support remote forces will occur, which will have a potentially severe impact in a crisis.

The decision to modernize overseas POL facilities is complicated by the reality that host nations, at some future date, may not elect to support U.S. installations. Therefore, the investment risk is often high, and, consequently, other competing construction projects generally take precedence in the budget review process.

3.5.3 Standardizing Fuel

The ASD(I&L) established the DOD fuel standardization policy through DOD Directive 4140.43, of 5 December 1975. The directive prescribes greater flexibility in procuring and using fuels by the U.S. military. Also, the directive calls for a reduction in the number of fuels in the military logistics system.

Standardizing readily available commercial products, pursuant to the DOD Directive, will probably reduce procurement problems and expenses in the future, while increasing flexibility through the use of available local products when military specification products are not available. The fuels distribution system will also be simplified. Standardizing within the Navy has yielded benefits: JP-5 can be substituted for JP-4 and diesel fuel, thus reducing the cost of storage facilities and the number of products for which handling facilities must be constructed.

The SYSCOMs design and procure weapons systems and equipment, and, therefore, must conform with applicable DOD directives. NAVPETOFF must, therefore, coordinate all fuel specification changes with the SYSCOMs, with particular emphasis on the impact of changes on logistics and support systems.

In conforming with the DOD fuel standardization policy, the Navy is pursuing conversion of all mobile forces to JP-5 and DFM. Also, a single standard residual fuel is being evaluated for shoreside utilities. Conforming with this policy also affects research and development and weapons procurement programs. The Navy is coordinating all new fuel requirements and policy with other DOD components and with the North Atlantic Treaty Organization (NATO) allies to achieve maximum standardization and substitutability. Operating fleet units requiring other than JP-5 or DFM are being replaced by units that would use these fuels. All fleet units were scheduled to be converted or decommissioned by July 1976.

The NATO nations have been striving, since the early 1950s, to convert to standardized fuels to facilitate logistics support in case of an emergency. Benefits of this program were demonstrated, in part, during the Arab oil embargo. However, not all NATO nations have a plan for near-term conversion to standardized fuels. Although British and West German (FDR) navies have essentially converted to DFM, French and Italian navies have not. Smaller NATO nations do not have a conversion schedule because they lack resources or because of other economic limitations.

The standardized fuels program has not produced significant unit price reductions to DOD, as compared with normal bulk commercial fuel prices. In some cases, continuing to use non-standard fuels may cause significant budget penalties. The Navy's principal aircraft fuel, JP-5, is a specialized military fuel for which there is no commercial demand. Commercial aviation fuels are not safe for shipboard operations; consequently, the Navy has almost no flexibility in using commercial aircraft fuels for major critical Navy operations. Also, the limited demand for JP-5 fuel generally produces higher unit cost.

Regional emission standards vary within the United States and for the Navy's foreign installations. The wide range of regional emission standards complicates single boiler fuel use for the Navy's shoreside utilities. These fuels are purchased to comply with local standards (not only state, but sometimes county or other local standards may be involved). To standardize a single fuel to comply with the most stringent emission standards would not be practical. Therefore, the Navy will continue to purchase utility boiler fuels on a regional basis for the near future.

The Navy's logistics systems partially support U.S. Air Force facilities. Handling and storing standardized Air Force jet fuels (JP-4 and JP-8) must be separated from shipboard fuels for safety reasons.

3.5.4 Pollution Abatement Control

The National Environmental Policy Act (NEPA) was so significant that it stalled the Alaska pipeline project for several years. Basically, NEPA requires that every federal action (including development of overall federal plans) be assessed to determine environmental effects. If these assessments show "significant effect on the human environment," or are, in any way, environmentally controversial, an environmental impact statement must be written and made public.

OPNAVINST 6240.3D, of 24 April 1975, is the "Environmental Production Manual" establishing the Navy's policy for complying with all federal, state, and local environmental protection laws and regulations.

The Navy's objective is to promote positive and full cooperative endorsement of all environmental regulations and to further institute an active program for environmental quality awareness for all Navy personnel. The instruction includes (partial listing): environmental impact statements; water pollution abatement ashore; air pollution abatement; oil and hazardous substances; shipboard wastes; noise abatement; solid waste disposal and resource recovery; ocean dumping and dredging; conservation measures (soil and water management); protection of historic properties; the SECNAV environmental protection annual awards program; and the SECDEF Natural Resources Conservation Award. The instruction also establishes a Navy Environmental Protection Support Service (NEPSS) within NAVMAT to assist all ships, aircraft, and shore installations in keeping informed of the latest legal policies and the Navy's position on environmental actions.

The Environmental Protection Manual delineates the responsibilities of CNO, CNM, several other central Navy authorities, major claimants, subordinate commands, and general Naval personnel. Major responsibilities include:

a. The Deputy Chief of Naval Operations (Logistics) essentially establishes policy, directs, coordinates, and monitors the Navy's environmental protection program. OPNAV also effectively coordinates with ASD(I&L) and with non-DOD agencies involved in environmental quality matters.

b. The Chief of Naval Material identifies and evaluates, on a continuing basis, Naval systems and equipment affecting environmental quality, validates all material-related facility projects and corrects environmental deficiencies, performs research to define and study environmental pollution problems, and coordinates such research actions with the Navy's commands, other DOD components, and federal agencies. NAVMAT also centrally manages logistics requirements and assures that the budget and FYDP will adequately provide for the environmental protection program.

c. Major claimants are principally responsible for adequate environmental quality and natural resources management programs. Major claimants and subordinate commands identify and maintain information concerning all aspects of their operations that significantly effect environmental quality, and determine the feasibility of taking any necessary actions to improve environmental quality. Major claimants also supply budget estimates for environmental protection. A focal point for environmental matters is established in each major claimant, and each coordinates all internal Navy actions and programs within each area of responsibility.

NAVFAC, as directed by CNM, collates the Navy's air, water, solid waste, noise, pesticide, and radiation pollution deficiencies and plans and coordinates the corrective measures. Requirements which have been submitted by major claimants are eventually directed to CNO through CNM. These reported deficiencies are incorporated in the Navy Pollution Control Report (OMB Report). NAVFAC also establishes criteria for assigning priorities for corrections or projects listed in the OMB Report.

NAVFAC has proposed (NAVFACNOTE 6240, 28 January 1976) to initiate surveys of selected Navy petroleum handling facilities. The primary objective will be to identify typical spill prevention control and countermeasures (SPCC) and water pollution deficiencies originating from the design, construction, operation, and maintenance of petroleum facilities, and validate SPCC projects for pollution abatement funding. Previous studies conducted at selected petroleum facilities produced guidelines for all facilities to comply with EPA and Coast Guard regulations.

3.5.5 Defense Energy Information System (DEIS)

During the Arab oil embargo of 1973-74, DOD determined that timely and accurate energy inventories and consumption information was restricted entirely to bulk fuel terminal operations. The exigencies of the situation required definitive information from all levels regarding individual base/unit/activity energy inventories and consumption. In response to this energy information requirement, the DEIS was developed.

Objectives of the DEIS are to:

a. Supply energy consumption data for planning and budget review.

b. Provide inventory status to assist in distribution/redistribution planning.

c. Furnish energy consumption data to monitor progress of the energy conservation program.

Development of the DEIS program was led by ASD(I&L) and DSA, with each of the services participating. DFSC maintains and updates DEIS-I for shipboard and aircraft energy consumption, and DEIS-II for military installations and shore facilities.

NAVPETOFF monitors the final DEIS-I report to ensure that the Navy's data is accurate and complete and also supplies special summary reports for CNO. All major claimants must fill out and submit DEIS-I report forms monthly. DFSC receives these reports and puts them into the DEIS-I automated data bank. The computerized system then generates monthly compilations of the use of the various standard fuel types by each of the services. The program categorizes data according to several breakdowns and summarizes overall fuel use.

NAVFAC is the program coordinator for DEIS-II. It provides quality control, activity guidelines, and analysis of the data to CNO. DEIS-II also provides a monthly report of facility energy consumption to major claimants, enabling facility managers to be aware of energy costs on a timely basis.

3.5.6 POL Training

The Navy uses about 60 million barrels of fuel per year. This includes POL for almost 500 ships, over 5,000 aircraft, and all the Navy's shore facilities. This consumption is substantially less than the 110 million barrels consumed in 1970. These products are stored, transferred, and used at practically every Naval facility, both ashore and afloat. The fivefold increase in POL prices in the past few years has caused annual restrictions on ship operating days and aircraft flying hours. This has led to an energy conservation program, afloat and ashore, to ensure the maximum return for the fuel expended. Simultaneously, national environmental awareness has produced operational restrictions and increased budget commitments to antipollution efforts.

POL training requirements cover several areas. Personnel must be trained in operational and quality assurance procedures and techniques for handling ship propulsion and aviation fuels. This includes personnel on shore terminals and bases, airfields, and on virtually all of the Navy's ships. A few years ago, the only need for afloat POL-trained personnel for aviation fuels was on carriers. The growing use and capability of rotary wing aircraft throughout the fleet has drastically increased the number of mini JP-5 fuel systems afloat. For example, in the Surface Force Pacific Fleet, 115 ships have JP-5 capabilities. The training program must be able to supply qualified personnel, officers, and enlisted men, for the following areas:

	Aircraft	Ship Fuels
Fuel terminals	X	X
Air bases	X	
Ship bases	X	X
Ships (with JP-5)	X	X
Ships (without JP-5)		X
Afloat staffs	X	X

The fuel-related activities of the Navy have gained publicity, as well as interest from GAO, Navy Audit Service inspections, and Congress. In turn, fleet commanders have shown a growing and more active interest in the POL training program. CINCPACFLT conducted an informal survey of the POL training facilities under its cognizance and concluded that:

- POL training is not fully responsive to PACFLT's operational effectiveness.
- POL training is under the auspices of three PACFLT type commanders. This has caused a fragmented approach, involving duplication of effort in some areas, and/or no training in other areas.
- COMNAVSURFPAC Petroleum School's curricula must be revised.
- Control of the COMNAVSURFPAC Petroleum School should be transferred to a training-oriented command to achieve maximum mission effectiveness.

Although it is not explicit in these conclusions, the fleet commanders and NAVPETOFF feel that POL training must be more centrally directed to ensure effective coordination of Navy-wide POL training needs. Thus, CINCPACFLT is centralizing Pacific POL training (except the mobile aviation fuel team) under COMTRAPAC.

CINCLANTFLT is reviewing the possibility of consolidating the Atlantic Fleet POL training, presently at Little Creek and Fort Lee, into one school at Little Creek.

Because of the present situation, action should be initiated to prepare and implement a Navy-wide POL training plan. As a first step, the Deputy Chief of Naval Operations (Logistics) has requested that the Director, Naval Education and Training, review existing POL training courses used to train the Navy's personnel to:

a. Identify all resources devoted to POL training.

b. Examine existing curricula to consolidate and standardize.

c. Choose a course curriculum manager to maintain a standard "core curriculum."

d. Designate a single office to review POL curricula so that they are technically accurate and current.

e. Analyze the projected requirements, in conjunction with user commands, for POL trained personnel and recommend improvements involving the quality of training and the efficiency of using programmed resources.

Implementing this review will be an important first step in establishing a feasible POL training plan within the framework of and as an important component of an overall, comprehensive Navy Energy Plan.

3.6 ENERGY MANAGEMENT AND PLANNING STRATEGY

3.6.1 The Navy's Overall Energy Management and Planning

Almost three years ago, DETG acknowledged that energy-related responsibilities within DOD were fragmented and diffused. A functional energy organization chart at that time showed one office concerned with energy for operational readiness, another concerned with budgeting, and still another concerned with supply conservation. As stated in DETG's report, "almost every element in DOD performs a job that relates in some way to energy, but most people are concerned with energy as only a part of a larger function, and each views energy from a different perspective."[1] Energy organization and management problems were equally severe in the Navy.

Since availability of energy has become a problem, the Navy has made major advances in alleviating energy organizational and management shortcomings. The fragmented approach to energy management was recognized and a more centralized approach has been adopted. A Navy Energy Office and a CNO Energy Action Group, described in Appendix D, have been created as a visible and accessible focal point for energy matters. And most important, a process for the Navy's energy planning has been initiated to establish the basic direction of the Navy's future efforts and operations in the energy field. A continuing effort to improve coordination of energy matters within the DOD and with other federal agencies assures that duplication is minimized and common goals can be jointly pursued, whenever appropriate.

[1] "Report of the Defense Energy Task Group," 15 November 1973, pp 1-8.

Through DEIS I and II, a total energy information data base is being developed that will help plan decisions in the energy area and also permit measures to be taken to indicate whether the Navy is succeeding in achieving its energy goals.

In looking ahead and trying to determine the most critical elements that will affect the Navy's future energy posture, other than the significant roles of management and planning, time stands out. Generally, the Navy's procedures, organizational structures, and planning processes operate within annual budgets and the FYDPs. Planning and managing energy-related activities must span decades if optimum results are to be achieved. For example, major shore station conversions from natural gas to coal would take a decade and federal legislation calls for 10-year conservation plans to be submitted by federal agencies. The Navy's ship design policy extends into the 1990s. The Navy will have to deal with institutional and life style changes caused by limitations imposed by available energy resources and environmental standards. These needs demand a planning process that fully considers the long lead-times involved.

3.6.2 The Navy Energy Research and Development Plan

The Navy Energy and Natural Resources Research and Development Office was informally organized in July 1973 and formally chartered on 19 February 1974 under the direction of the Chief of Naval Material. A Navy research and development plan has been developed to define a course of action and provide a tool whereby the Director of the Navy Energy Research and Development Office may effectively carry out his assigned responsibilities. The plan gives the Navy a structured approach to energy research and development that responds to the Navy's energy requirements, and, at the same time, complements and becomes an integral part of the national and DOD energy programs.

Before the organization of the Navy Energy Research and Development Office in February 1974, a number of research and development efforts were initiated. These included: developing a comprehensive energy data base; analyzing the Navy's energy consumption for FY 1973 through FY 1975; examining all collected data to determine the impact an energy crisis would have on the Navy's operations; selecting key research and development goals, strategies, and objectives; and evolving detailed program plans. These efforts produced the Navy Energy Research and Development Program Plan, initially published in November 1975 and updated in November 1976.

Key strategies for the Navy's energy research and developme. . program have been selected and include: *energy conservation; synthetic fuels;* and *energy self-sufficiency.*

Energy conservation strategy involves eliminating wasteful energy use, developing more efficient propulsion designs and power generation, and improving basic energy systems so that they will use less energy.

The *synthetic fuels* effort involves initiating laboratory and testing projects to ensure that fuels derived from oil shale, tar sands, and coal are compatible with the Navy's equipment.

Energy self-sufficiency strategy involves developing local renewable energy such as solar, wind, geothermal, and waste energy sources at remote and domestic bases, and where possible, replacing liquid hydrocarbon fuels at domestic bases with more abundant fuels such as coal.

The Navy Energy Research and Development Office uses contractual and in-house technical support to publish a weekly situation report (SITREP), an annual energy fact book, an annual update of the Navy Energy Research and Development Program Plan, a semi-annual report of energy research and development progress, and technical reviews, evaluations, and reports, as required.

NEUPAS continually updates a computer-assisted tabulation and analysis of the Navy's energy usage, including ship, air, and shore operations. The study can project the Navy's energy requirements to FY 2000 and can also project energy needs for specific task force structures, when appropriate.

The Director of the Navy Energy Research and Development Office manages and supervises the Navy's energy research and development program. The Director reviews all the Navy's programs that involve: evolving energy technology or applications for assessing the feasibility of achieving program goals; validity of the technical approach; adequacy of management and funding, feasibility of proposed schedules, and the progress and future prospects of the program.

Detailed planning milestones, approved by the Director of Navy Energy Research and Development Office, are included in the Navy's energy research and development plan. Status reviews are conducted for each energy research and development strategy on a quarterly basis.

Table 3-6 shows the POM 78 funding levels, by category, for the Navy's energy research and development program.

Table 3-6. NAVY ENERGY RESEARCH AND DEVELOPMENT FUNDING LEVELS
(Millions of dollars)

	FY 1977	FY 1978	FY 1979	FY 1980	FY 1981	FY 1982
6.2 POM 78	5.2	5.8	5.3	5.5	5.7	6.0
6.3 POM 78	3.6	7.0	8.1	14.1	23.7	27.6
6.4 POM 78	2.3	2.8	3.5	6.6	9.4	11.0
6.5 POM 78	0.2	1.0	1.0	1.0	1.0	1.0
Total	11.3	16.6	17.9	27.2	39.8	45.6

4.0 THE NAVY'S POL SYSTEM

4.1 OVERVIEW

The Navy's POL system is made up of fuel terminals, fuel stocks, tankers/oiler vessels that transport the POL products to their point of issue, and the fuel management system, which directs the day-to-day operations of the system. The terminal system includes those operated by the Navy, other services, DFSC, NATO, commercial interests, and foreign governments. The system is a network of about 50 major terminals with a normal in-service tank capacity of more than 35 million barrels. These tanks are normally about 85 percent full with a product whose total value is about $500 million (carried in the DSA stock fund). In addition, there are many installations (the Navy's bases and airfields) that have smaller fuel storage facilities whose product is held in the Navy's stock fund. Fuel stocks at the major terminals are bought, owned, managed, and controlled by DFSC. Although many various grades of POL products are stocked, the Navy is specifically interested in DFM for ships, JP-5 and aviation gasoline for aircraft, NSFO for MSC and charter vessels, and motor gasoline for shore-based vehicles. The fuel stocks are composed of products procured to satisfy prepositioned war reserve material requirements and peacetime operating stock needs. Every day the Navy issues 160,000 to 180,000 barrels of product to the Navy and Marine Corps. This means handling about 320,000 to 360,000 barrels per day (in and out) to make the product available at the point of issue.

The fuel is transported to its point of issue by a group of fleet controlled AO, AOE, AOR, and TAO oilers and MSC controlled MSCs and charter tankers. The fuel in the fleet-controlled oilers is carried in the Navy's stock fund with fuel from the smaller installations. Although the figures vary, the normal level of fuel funds in the Navy's stock funds is about $86 million, of which $40 million is for fuel afloat and $46 million is for fuel ashore.

PWRMR are part of the mobilization reserve materiel needs that approved plans dictate be positioned before hostilities begin, either at or near the point of planned use or issue to the user. This is to ensure timely support of a specific project or designated forces during the initial phase of war until normal resupply is established. One of the most important components of PWRMR is bulk petroleum products to be used by the active Navy and NRF, MSC, Coast Guard, and U.S. Marine Corps. The PWRMR program supplies POL needs for ships, aircraft, CNO Special Projects, and overseas shore bases. The Office of the Chief of Naval Operations, DFSC, fleet commanders, and ASD(I&L) are responsible for the program that includes: specifying requirements; designating the location and level of terminals to store PWRM stocks; provisioning PWRM stocks to designated terminals; and managing the system.

Before 1974, PWRMR (then known as Prepositioned War Reserve Requirements (PWRR)) for bulk petroleum products were computed according to procedures delineated in the OPNAVINST S4020.15 series. During this period of relatively inexpensive fuel ($2.50 per barrel), it was not necessary to carefully monitor fuel consumption or determine fuel needs. Thus, some of the PWRR computational procedures were rudimentary and random.

Just prior to the Arab oil embargo of 1973-1974, it was decided to develop a computer model of POL PWRMR using the methodology from the then effective OPNAVINST S4020.15G. Two existing files, the Ship Management Information System (SMIS) and the Aircraft Program Data File (APDF), were used to develop the new model. SMIS file gives current and programmed ship information from the FYDP for the Navy's ships. APDF furnishes equivalent information for the Navy's aircraft. Other key inputs for the model were: OPTEMPO information obtained from a CNO study entitled "Consumption Factors and Requirements Estimates for Ship Propulsion Fuels," dated 19 April 1966; consumption rate information taken from official publications NWIP 11-20 and NWIP 11-21 (since superseded by NAVMAT P-4000-2); and day-of-supply (DOS) information recommended by the Joint Chiefs of Staff (JCS SM-64-74 of 6 February 1974).

Developing the model progressed until it was discovered that guidelines, furnished in OPNAVINST S4020.15G, were not in accordance with the latest Secretary of Defense "Defense Policy and Planning Guidance (DPPG)" and "Planning and Programming Guidance Memorandum (PPGM)." Although many of the elements in the PWRR computation could not be justified by current planning guidelines, many elements that could be justified were not included. With the impetus of sixfold increases in POL prices, the entire computational procedures were reexamined and updated before the model could be completed. Thus, the PWRR methodology was revised and appeared as an enclosure to the updated OPNAVINST S4020.15H of 31 January 1975.

4.1.1 Fuel Management

Before 1973, the Navy Fuel Supply Office (NFSO) was responsible for the entire fuel program of the Navy. This included buying, distributing, and storing all the Navy's bulk fuels for PWRM and peacetime operating stocks. In 1973, DFSC assumed this responsibility and the NSFO became the Naval Petroleum Office (NPO).

NPO is responsible for:

- Assigning certain Chief of Naval Material and Supply Systems Command certain responsibilities in the POL field.
- Monitoring details of DFSC actions, with particular reference to stock levels and tankage.
- Certain training and technical activities.

4.1.2 The Fuel System

The objective of the Navy's fuel system is to have the proper type and amount of fuel available to supply the Navy's ships, aircraft, and other components at the desired locations, when needed. The system provides the required peacetime operating stocks (POS) and backup wartime stocks needed during initial phases of war, until normal resupply can be established. Although only peacetime functions of the systems are examined here, operating procedures will be the same in wartime.

A Navy ship normally obtains fuel from: a Navy or MSC oiler; another Navy ship; Naval base; local bunkering agent; and foreign naval sources.

The POL stocks in a Navy or MSC fleet support oiler are held in the Navy's stock fund. When fuel is transferred to a Navy ship, and the ship is the end user, custody of the fuel is taken by the commander and the fuel is charged to the type commander's, and eventually fleet commander's fuel allotment.

Fuels may be received from another Navy ship (a carrier fueling a destroyer), in which case, there is a ship-to-ship transfer that eventually becomes a type commander's transfer of funds.

Fuels received from a Naval base may be two types: either on-base stocks that are carried in the Navy's stock fund or, if the base is contiguous to a DSA (DFSC) controlled terminal, stocks received directly from DFSC that are carried in the DSA stock fund.

A ship may have to take on fuel in a remote area. In some cases, it may be in a port that has a local DFSC bunkering contract and agent. If not, it will have to obtain fuel using local purchase methods at the going rate through local bunkering agents.

Fuels may also be obtained from foreign navy sources. In some instances, these are covered by government-to-government agreements (as with the British); in others, cash payment is required.

Navy and MSC fleet support oilers normally carry their fuel stocks in the Navy's stock fund. These stocks are normally replenished from DFSC controlled terminals, where custody of the fuel is transferred from the DSA's stock fund to the Navy's stock fund. All fuels at DFSC terminals are kept at proper levels by a slating process carried out by the DFSC headquarters. This process is based on demand rate, resupply increment and frequency, safety level, and authorized deviations.

Navy aircraft normally receive fuel from: aircraft carriers; Naval air stations; other CONUS airfields; and foreign airfields.

Carrier aircraft, when on carriers, receive their fuel via the carrier fuel system. Aviation fuel stocks are received the same way ship propulsion fuels are obtained on board the carrier. As the fuel is placed into the planes, it is charged against the fuel allotment of the squadron to which it is assigned.

When carrier aircraft are based at an airfield, they obtain fuel in the same way that normal shore-based aircraft obtain fuel.

Normal stocks at Naval air stations are carried in the Navy's stock fund. When the fuel is placed into Naval aircraft, it is charged against the allotment of the squadron or parent agency of the aircraft. If fuel is received from other government agency installations (Army, Air Force, FAA, etc.), there is an inter-departmental exchange of funds.

For major commercial airfields in CONUS and overseas airfields, DFSC arranges into-plane contracts for delivery of fuel. The pilot uses an identaplate (similar to a credit card) when purchasing fuel. At other locations, local purchase procedures are carried out and procedures vary.

The Naval air stations receive their on-base stocks in two ways. For stations adjacent to DFSC terminals, DSA's stock fund stocks are furnished directly and custody is normally transferred to the Navy's stock fund. In other locations, (generally inland), base stocks are replenished through local DFSC contracts. The DFSC slates DFSC terminal aviation fuel stocks the same way it does ship fuel stocks.

The terminal system that supports Navy requirements includes many different systems. First, there is the worldwide Navy deepwater terminal system, which has various components and is managed by fleet commanders and NAVSUP. In Europe, although the NATO terminals at Augusta, Gaeta, Cagliari and Souda Bay are controlled by the NATO host country, they obtain DFSC owned product.

Second, there are terminal systems created by bilateral agreements in Spain and in the United Kingdom. Although the organizational structures vary, these terminals are generally under some national control of the host country and contain DFSC stocks.

Third, there are some Navy PWRMR stocks that are held in contractor terminals, as in Iceland and Naples; some are held in DFSC-controlled terminals in Newport, Rhode Island; and some are held in base stocks of other services, as by the Air Force in the Azores. The largest percentage of the Navy's PWRMS and POS is in the Navy operated worldwide deepwater terminal system.

4.2 CURRENT OBJECTIVES

4.2.1 PWRMR

The PWRMR model described in Section 4.1 was updated and used to determine the Navy's PWRMR (FY 1975 to FY 1977) and forwarded to DFSC to be included in the five year projections. It soon became apparent, through informal discussions with representatives of the fleet commanders, that the inputs used in the PWRMR model, which were taken from the 1966 CNO Study and the NWIPs, produced results that were inconsistent with some of the peacetime operating data. This data was available because, for the first time, accurate POL usage information was being accumulated, essentially through the Office of the Fleet Controllers. The accuracy of these inputs were investigated by:

a. Analyzing recent fleet usage profiles.

b. Examining SEAMIX type operational profiles and scenarios to use in updating PWRMR.

c. Consolidating results of a and b to recommend PWRMR OPTEMPOs and consumption rates so that they are consistent with fleet planning and usage.

The new recommended methodology, the effect on PWRMR levels, and the financial implications have been sent to the fleet commanders for comment. If approved, the present PWRMR computer model will be modified and the enclosure to OPNAVINST S4020.15H will be updated.

4.2.2 Fuel System

Because of low priorities at the fleet commander and CNO levels, a large backlog of maintenance work has occurred at many of the Navy's more important POL bulk terminals. This year a substantial amount of money has been programmed for repairs to the more important tank facilities in the Atlantic and Pacific. While there has been progress in rectifying certain tankage shortages throughout the world, NATO projects have been normally late in coming on-line, and the internal situation in some countries has not been conducive to either completing new facilities or repairing old ones.

4.3 RESPONSIBILITIES

PWRMR's responsibilities are divided among: ASD(I&L); ASD (Comptroller); Director, DSA; Commander, DFSC; Chief of Naval Operations; and Fleet Commanders-in-Chief.

The ASD(I&L) establishes policies and provides guidance for DOD's petroleum logistics programs, systems, and procedures, and assures their effective implementation.

The ASD (Comptroller) directs the financial management program pertaining to functions and activities of the stock fund (where PWRMR stocks are carried), property accounting, and resource management systems.

The Director, DSA has integrated material management (IMM) responsibilities for petroleum products including ownership and accounting for the bulk petroleum war reserve and peacetime operating stocks.

The Commander, DFSC coordinates the procurement of all petroleum products, coal, and related services. He is the integrated material manager for bulk petroleum products and performs contract administration overseas.

The Chief of Naval Operations, with assistance from the Chief of Naval Material, Commandant of the Marine Corps, Commander, Military Sealift Command (MSC), and the Commandant, U.S. Coast Guard annually computes (for a five-year period) worldwide PWRMR for bulk petroleum products by area and reports the findings to DFSC as a storage requirement. The Chief of Naval Operations also maintains PWRMR's computational procedures and data inputs, as required, to reflect changes in force structure, war plans, and logistics.

The Fleet Commanders-in-Chief (CINCLANTFLT, CINCPACFLT, and CINCUSNAVEUR) designate to DFSC terminals that store Prepositioned War Reserve Material Stocks (PWRMS) within their theaters, and assign individual terminal and base PWRMS levels.

4.4 POLICIES

Basic petroleum management policies are contained in DOD Directive 5105.22, and DSA and DOD Directive 4140.25, and DOD 4140.25-M, Procedures for the Management of Petroleum Products, dated August 1974. Although they provide detailed guidelines, they are being updated and revised. The Navy's PWRMR policy is found in OPNAVINST S4010.15H, dated 31 January 1975.

5.0 NAVAL PETROLEUM AND OIL SHALE RESERVES

5.1 BACKGROUND

5.1.1 Creation of Naval Petroleum and Oil Shale Reserves

At the turn of the century, public lands in the United States were quickly passing to private ownership. This was taking place primarily as the result of various statutes aimed at opening up the resources of the great American West. The transcontinental railroads, for example, had received millions of acres as a subsidy for pushing the tracks across the nation.

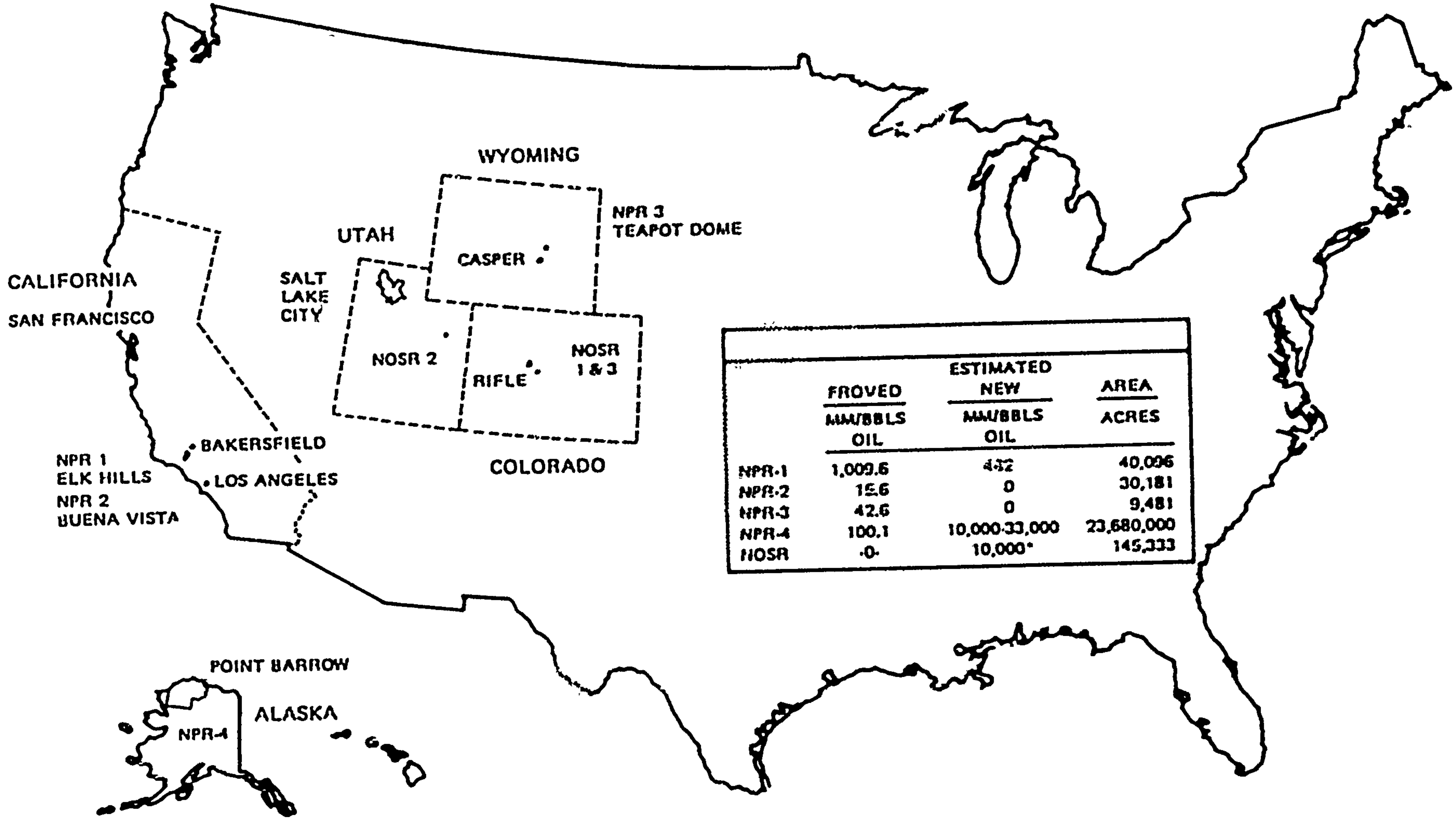
During this period, the federal government began to realize that oil was destined to play an important role in the future. The Navy was already contemplating a conversion of the fleet from coal to petroleum, and it was concerned about the need for an adequate stockpile of the new fuel. President Theodore Roosevelt was an ardent supporter of a strong Navy, and he took steps to ensure that the fleet would have enough petroleum. He asked the U.S. Geological Survey (USGS) to investigate public lands and to recommend any tracts that might contain oil reservoirs.

Government geologists completed their assignment after President Taft had replaced Roosevelt, and so it was President Taft who signed the Executive order on September 27, 1909 that temporarily rescinded certain large areas in California and Wyoming from entry and settlement under public land laws. Taft requested Congress to enact legislation vesting the President with discretionary power to make temporary withdrawals of the public domain. Congress responded with the "Picket Act" on June 25, 1910. Withdrawals were to remain in effect until revoked by the President or an act of Congress, and the statute expressly recognized the validity of pre-existing claims. After passage of the act, President Taft confirmed the earlier withdrawals.

5.1.2 Specific Reservations for the Navy

President Taft's two withdrawal orders had mentioned neither the Navy nor allocated any of the lands involved to the Navy for its benefit. The lands affected were merely revoked from private entry and continued to be a part of the public domain under jurisdiction of the Department of the Interior.

However, in 1912, the General Board of the Navy recommended to the Secretary of the Navy that "permanent reservations be made for future naval fuel-oil supplies." Accordingly, Naval Petroleum Reserves, shown in Figure 5-1, were set aside.



	PROVED MM/BBLS OIL	ESTIMATED NEW MM/BBLS OIL	AREA ACRES
NPR-1	1,009.6	432	40,096
NPR-2	15.6	0	30,181
NPR-3	42.6	0	9,481
NPR-4	100.1	10,000-33,000	23,680,000
NOSR	-0-	10,000*	145,333

Figure 5.1. NAVY'S PETROLEUM AND OIL SHALE RESERVES IN CONTINENTAL UNITED STATES

5.1.2.1 Naval Petroleum Reserve No. 1 (Elk Hills)

On June 25, 1912, the Secretary of the Navy asked the Secretary of the Interior for cooperation in securing for the Navy the reservation of oil-bearing public lands in California, which would be sufficient to ensure a supply of 500 million barrels of oil. In response to this request, the USGS recommended an area of 38,072.7 acres in the Elk Hills of Kern County, California. Accordingly, President Taft issued an Executive order, dated September 2, 1912, setting aside these lands as Naval Petroleum Reserve No. 1 (NPR-1). In NPR-1, 12,103.09 acres were legally patented to private owners and the balance of 25,969.62 acres belonged to the government. At that time, no actual discoveries of oil had been made, and selection of the area had been based mainly on general knowledge of its geology. No one knew whether it contained more or less than the 500 million barrels of oil that the Navy had requested. Recoverable reserves are now estimated to be more than twice that amount.

5.1.2.2 Naval Petroleum Reserve No. 2 (Buena Vista Hills)

Since the exact amount of oil in NPR-1 was unknown, the USGS proposed a second reservation of 30,180.69 acres in the Buena Vista Hills of Kern County after discovery of oil in 1910. This proposed withdrawal was immediately adjacent to a part of the southern boundary of NPR-1. Accordingly, President Taft created NPR-2 by an Executive order, dated December 13, 1912.

In NPR-2, 19,090.94 acres were patented to private owners and the balance of 11,089.75 acres was still owned by the government. However, the Department of Justice was actively preparing suits to challenge land patents granted to the Southern Pacific Railroad that involved some 18,000 acres in NPR-2. This suit was later unsuccessful, and in 1919, title to the railroad's lands was confirmed by the Federal Courts when the Department of Justice failed to pursue the suit through the courts.

5.1.2.3. Naval Petroleum Reserve No. 3 (Teapot Dome)

On June 29, 1914, the Secretary of the Navy wrote the Secretary of the Interior requesting the nomination of possible sites for a proposed petroleum reserve in Wyoming. Of the suggested locations, the Navy preferred a tract known as Teapot Dome. Unlike the two reserves in California, all of the Wyoming acreage was owned by the government, and, therefore, none of the problems created by the presence of private holdings existed. President Wilson's Executive order of April 30, 1915 designated Teapot Dome as NPR-3.

5.1.2.4. Naval Petroleum Reserve No. 4 (Alaska)

On February 27, 1923, President Harding signed Executive Order No. 3797A, designating 37,000 square miles in the northern part of Alaska as NPR-4. Virtually none of this area had ever been explored, but oil seepages had been reported, indicating the existence of large hydrocarbon deposits.

5.2 The Naval Oil Shale Reserves

5.2.1 Naval Oil Shale Reserve No. 1 (Colorado No. 1)

As a further guarantee of oil for the Navy in future emergencies, the government decided to segregate certain sections of public lands containing oil shale that could be processed into liquid hydrocarbon fuels. President Wilson, by an Executive order, dated December 6, 1916, stipulated 44,560 acres of public lands in Colorado as NOSR-1. By an Executive order, dated June 12, 1919, some 3,800 acres of NOSR-1 was restored to the public domain.

5.2.2 Naval Oil Shale Reserve No. 2 (Utah No. 1)

President Wilson, by an Executive order, dated December 6, 1916, established NOSR-2 in Utah. Acreage was added to NOSR-2 by an Executive order, dated November 17, 1924, and NOSR-2 presently totals about 90,440 acres, of which 640 acres are state lands and 320 acres are homestead entries. NOSR-2 has oil and gas patents held in reserve for the federal government.

5.2.3 Naval Oil Shale Reserve No. 3 (Colorado No. 2)

NOSR-3, established by an Executive order, dated September 27, 1924, borders NOSR-1 on the east, south, and west. Although less than 15 percent of NOSR-3 contains oil-bearing shale, the land was withdrawn to give necessary working space and waste disposal areas for anticipated operations on NOSR-1.

5.3 ADMINISTRATION OF THE RESERVES

Before the Mineral Leasing Act of February 25, 1920, Naval Petroleum Reserves were a subject of considerable litigation involving titles of private claimants. At that time, the Navy had no authority to explore or develop the reserves.

The Fuel Oil Office was established on April 30, 1920 by the Secretary of the Navy. This excluded the Bureau of Steam Engineering from any administrative functions involving petroleum reserves.

Congress, by an act of June 4, 1920 (41 Stat. 813), placed Naval Petroleum Reserves expressly in possession and under authority of the Secretary of the Navy. It directed the Secretary to: take possession of all properties within Naval Petroleum Reserves not subject to earlier claims; conserve, develop, use, and operate reserves at either his discretion, directly or by contract, lease, or otherwise; use, store, exchange, or sell the oil and gas produced there for the benefit of the United States.

President Harding, by Executive Order No. 3473 on May 31, 1921, transferred administration of reserves to the Secretary of the Interior. The period that followed was highlighted by the notorious Teapot Dome Scandal, resulting in congressional investigations into the circumstances of the leasing of portions of NPR-1 and 3 by the Interior Secretary. Later, litigation led to cancellation of such leases, and, on March 17, 1927, the reserves were returned to the jurisdiction of the Navy, pursuant to Executive Order No. 4614. In October 1927, the Secretary of the Navy established, as part of his office, the Office of Naval Petroleum and Oil Shale Reserves. Navy control over the reserves was completed by an act of Congress on February 25, 1928 (45 Stat. 148), which transferred from the Secretary of the Interior to the Secretary of the Navy power to administer all outstanding leases on the reserves.

The act of June 4, 1920 has been amended several times to continue its vitality and to provide Congressional authorization of the reserves. Amendments include: acts of June 30, 1938 (52 Stat. 1252); June 17, 1944 (58 Stat. 280); August 24, 1962 (76 Stat. 401); and October 11, 1962 (76 Stat. 904).

The Navy did not have authority to operate or develop oil shale reserves until enactment of Public Law 87-796 on October 11, 1962 (76 Stat. 904). The primary function of this law is to give the Secretary of the Navy essentially the same rights and responsibilities with Naval Oil Shale Reserves as he has with Naval Petroleum Reserves.

The President, in April 1976, signed the Naval Petroleum Reserves Production Act of 1976 (Public Law 94-258). Title I of this law transfers jurisdiction of NPR-4 to the Department of the Interior, effective 1 June 1977. Title II of the law states the Naval Petroleum Reserves will include the Naval Oil Shale Reserves and directs production from NPR 1, 2, and 3. This act also establishes a special account for depositing receipts from any of the reserves, and authorizes appropriations be made from this account to: explore, develop, and operate Naval Petroleum Reserves; construct strategic storage reserves established by the Energy Act of 1975; and continue exploring NPR-4 by the Department of the Interior, after 1 June 1977.

As a result of Public Law 94-258, Naval Petroleum reserves are no longer in the Navy/DOD budget except for manpower requirements. Appropriations may be made from the special account, as well as from the normal Treasury accounts.

Excluding NPR-2, none of the reserves have been fully explored or developed. NPR-1 had produced at a rate in excess of 60,000 barrels of oil per day (BOPD) during the latter stages of World War II, pursuant to a Joint Resolution of Congress. Production was decreased after the war. A major development program was initiated in the late 1940s and terminated in the early 1950s. NPR-1, one of the largest oil reserves in the United States, has not been fully explored. However, the Arab oil embargo of 1973 focused attention on the need for additional exploration and development of this reserve. Beginning with a supplemental appropriation act in FY 1974, funds have been set aside for this. Because of increased funding, NPR-1 is being fully explored and developed. Enactment of Public Law 94-258 provides that receipts from production may be appropriated to fund exploration and development of NPR-1, as well as the other reserves.

NPR-3, Teapot Dome, languished for many years after the Teapot Dome scandal of the 1920s. Offset operations in the 1950s caused the Navy to produce oil from the field to prevent its loss to operators outside the reserve. Public Law 94-258 provides that NPR-3 will be fully developed and produced.

A major exploration program was initiated in NPR-4 in 1944 and was terminated in the early 1950s. This effort, producing some 100 million barrels of oil and large quantities of gas, established many operating procedures still used today on the North Slope.

From 1944 to 1956, the Bureau of Mines conducted experimental work at the Rifle Oil Shale Demonstration Plant on NOSR-1 and 3 under the Synthetic Liquid Fuel Act. Enactment of PL 87-896 not only allowed the Secretary of the Navy to have the same powers over shale reserves as he has over petroleum reserves, but also enabled the Department of the Interior to lease the idle research facility in Colorado for research. In 1972, the facility was leased to Development Engineering, Inc. (DEI) to conduct research on oil shale retorting and related matters. The Energy Reorganization Act of 1974 transferred authority from the Secretary of the Interior to the Administrator of ERDA. ERDA and the Navy Research and Development Office are considering further production from the DEI retorting to supply additional shale oil for research and development.

5.4 FUTURE PLANS FOR THE NAVAL PETROLEUM AND NAVAL OIL SHALE RESERVES

Public Law 94-258 directs that NPR-1, 2, and 3 produce at the maximum efficient rate. The production period will be six years, unless the President recommends an additional three years, and there is no objection from the House or Senate.

The existing program to explore and develop NPR-1 will continue for the next several years to recognize its full potential. In addition, the Navy, in response to Public Law 94-258, will provide pipeline to handle as much as 350,000 barrels per day from Elk Hills within three years of enactment of the law (5 April 1976).

The Navy is the minority land holder in NPR-2 and most of it has been under lease since the 1920s. NPR-2 offers little in the way of increased production potential. The Navy receives royalties on production from this reserve.

NPR-3 was created only for testing, before Public Law 94-258, and average daily production was less than 300 barrels. A development plan for NPR-3 will set a peak production of about 20,000 BOPD and an average production of about 12,000 BOPD over the next five years. Existing pipelines are adequate to handle production from this reserve.

Public Law 94-258 requires that NPR-4 be transferred to the Department of the Interior, effective 1 June 1977. This includes 26 wells, and the 10,000 mile seismic program that will be continued by the Interior Department after the transfer. Prior to the transfer, the Navy will probably drill five wells, in addition to three that have already been drilled. No significant reserves have been found as a result of the three wells, but a geologist would say they were "geological successes."

Naval Shale Oil Reserves have oil shale containing 15 gallons per ton (GPT) or more that will yield 16 billion barrels. This is worth a great deal of attention. NOSR-1 and 3 are considered as a single unit, with a potential yield of 12 billion barrels extracted from 15 GPT. A six-year predevelopment plan for the Colorado Oil Shale Reserves is under way. However, additional field data is needed to more fully define the oil shale resources, ground water potential, water-runoff, engineering requirements, as well as environmental evaluation of various methods of mining and retorting oil shale, and disposing of the spent shale. After completing the plan in FY 1982, the Navy will have an environmental impact statement showing development of the Colorado Oil Shale Reserves, as well as a proposed development plan to be considered by Congress.

A similar predevelopment plan is being considered for Utah Oil Shale Reserves. Additionally, a seismic exploration program is being prepared to help evaluate the oil and gas potential of this reserve because of oil production in the general vicinity.

By law, the Secretary of th [illegible] ohibited from developing Naval Oil Shale Reserves to compete with privat [illegible] this matter must be included in final plans to Congress.

The policy of the Office of Naval Petroleum and Oil Shale Reserves is to carry out mandates of Congress, as provided by law. Implementing this policy has resulted in exploration, development, and production programs for NPR-1 and 3, an exploration program for NPR-4, and a predevelopment plan for oil shale reserves. The Office of the Naval Petroleum and Oil Shale Reserves continues to encourage research in oil shale related matters by government and private industry. Implicit in this policy is a close working relationship with ERDA and other groups interested in oil shale.

6.0 THE NAVY'S ENERGY STRATEGIES AND PROGRAMS

6.1 INTRODUCTION

This chapter assesses the status and accomplishments of each strategy and program, reviews organizational and technical approaches, and discusses the major uncertainties and tradeoffs. These assessments will provide an overview of the Navy's present energy planning, and, in turn, point out the Navy's planning strengths that can be exploited, and weaknesses that should be examined.

6.2 ENERGY CONSERVATION

6.2.1 Overview

Energy conservation will achieve a near- and mid-term impact on total Navywide energy consumption by practicing demand restraint and reducing inefficiency and waste. Specifically, conservation programs were primarily responsible for reducing the Navy's petroleum usage by 25 percent in FY 1975 over FY 1973 and 35 percent in FY 1976 over FY 1973. Consequently, the programs have played a major role in attaining the energy goal of reducing the Navy's dependence on foreign energy supplies.

Ships, aircraft, and shore facilities have reduced total energy consumed by decreasing inefficient and wasteful energy uses and by restraining energy use required in operational activities. For ships and aircraft, energy savings were achieved by practicing operational demand restraint. On shore facilities, more complex actions involving a reduction of inefficient and wasteful energy use and operational cutbacks were followed.

Figures 6-1 and 6-2 show that the Navy's energy savings are 33.5 million barrels of oil equivalent (BOE) for FY 1976 over FY 1973, valued at $460.4 million in current dollars. These figures also give a breakdown of how these savings were accomplished.

Primary energy savings over FY 1973 occurred by reducing energy-consuming equipment and operational demands, or OPTEMPO.

Energy conservation programs (energy engineering and others) will probably significantly produce further reductions without mission degradation. The potential for further reductions essentially depends on command leadership involvement and a more thorough understanding of the problem by the American public.

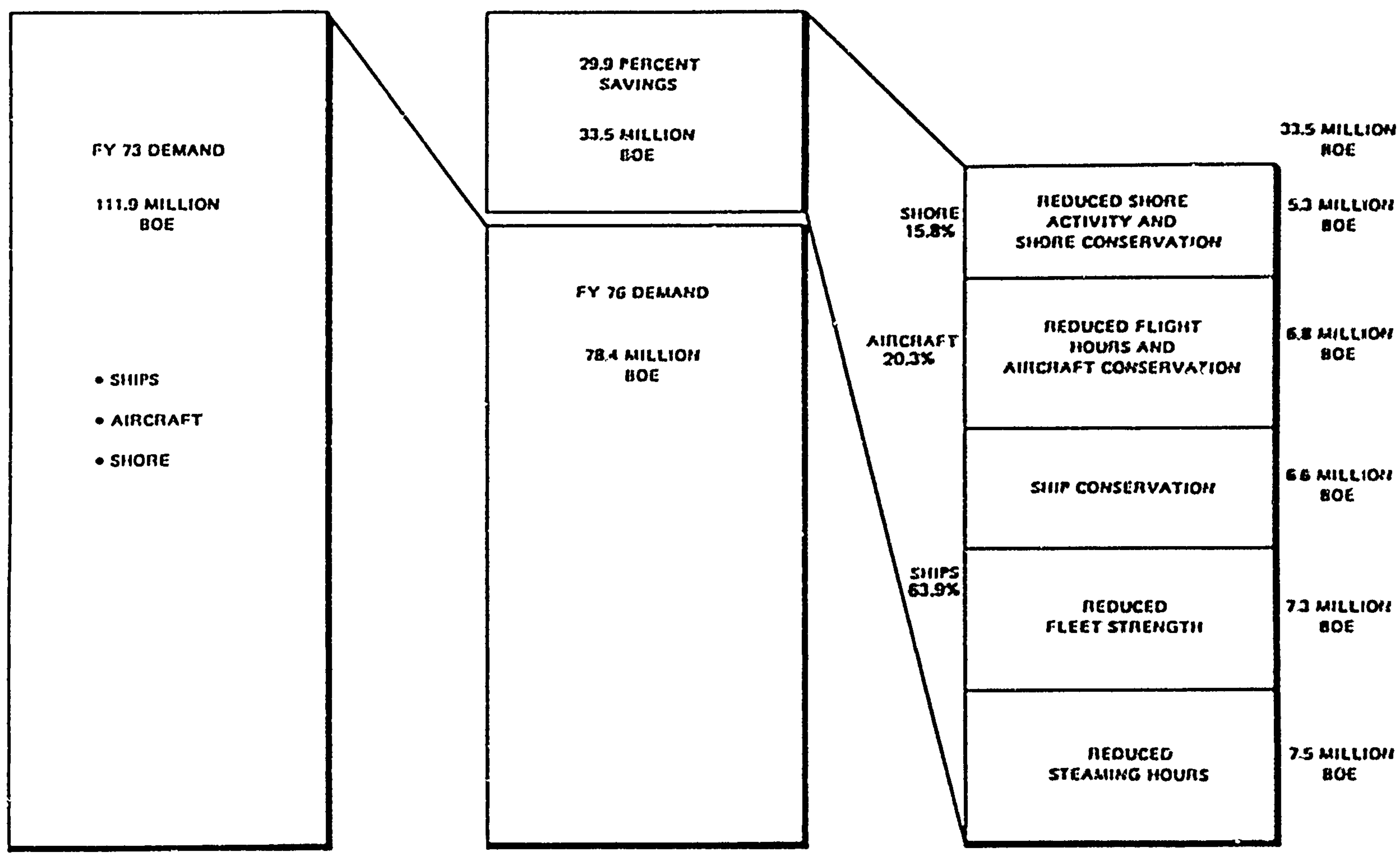


Figure 6-1. NAVY DIRECT ENERGY CONSERVATION PROFILE, FY 1976 (BARRELS OF OIL EQUIVALENT)

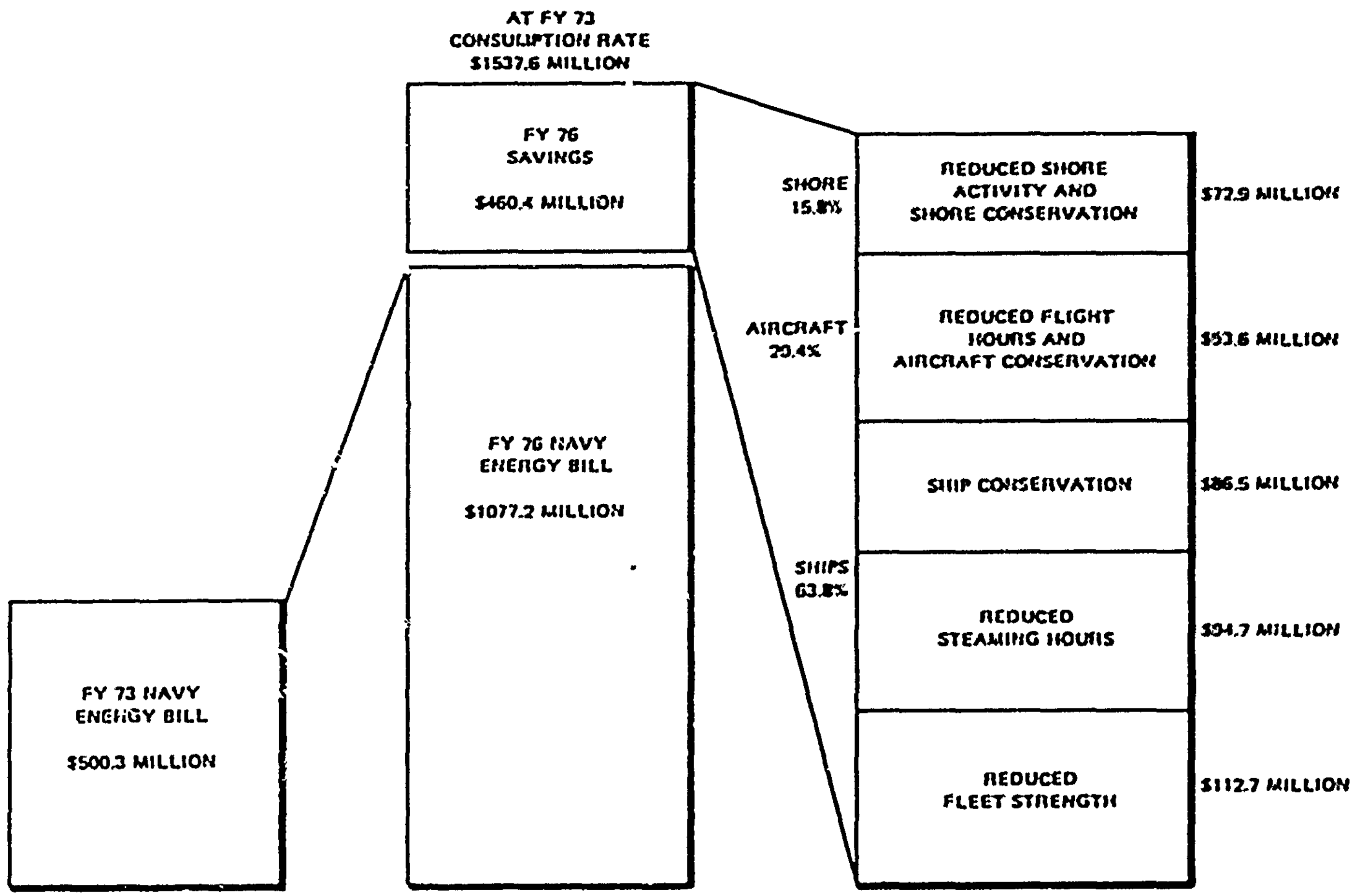


Figure 6-2. NAVY DIRECT ENERGY CONSERVATION PROFILE, FY 1976 (CURRENT DOLLARS)

6.2.2 The Navy's Future Efforts in Energy Conservation

The Navy's fuel demands can be projected by forecasting fleet composition and probable operating days per quarter. The curves in Figure 6-3 show the expected fuel consumption demand levels by the Navy's ships, aircraft, and shore facilities to FY 2000. Each set of demand curves includes a business as usual (BAU) estimate, which reflects energy demand levels without current energy conservation programs, and a Navy Best Assessment (NBA), which includes the conservative impact estimate of planned conservation programs. The difference in BAU and NBA is an accurate projection of the long-term impact of conservation programs in peacetime.

6.2.2.1 Shipboard Energy Conservation

The NAVSEA Energy Research and Development Office is developing near-term energy conservation measures for the Navy's ships. This office sponsors the shipboard energy research and development conservation program in which the main objective is to improve hull cleaning methods and optimize shipboard machinery systems. This program should produce guidelines to reduce energy consumption levels of the current fleet under normal operating conditions.

The curves of the projected impact of fuel conservation in ships (shown in Figure 6-3(A) are based on conservative estimates of the probable fleetwide impact of improving hull maintenance and optimizing machinery systems. The combination of these shipboard energy conservation measures is expected to produce a 10 percent annual reduction in shipboard fuel demand by 1980. Improved hull maintenance procedures alone may furnish a 10 percent annual reduction in shipboard fuel demand by FY 1985. Simultaneously, machinery optimization measures could produce a similar payoff. Ship trials will be conducted as part of the shipboard energy conservation research and development program to determine actual fuel reduction rate. Fuel conservation recommendations and guidelines should be available to the fleet as early as FY 1977 with emphasis on the most populous ship classes.

6.2.2.2 Aircraft Energy Conservation

Using flight simulators in NAVAIR will probably reduce the annual cost of the Navy's most expensive fuel. Maintenance, repair, and other cost savings are also valuable spinoffs. As Figure 6-3(B) shows, expected fuel savings from the program are about 6 percent to 7 percent of total JP-5 consumption, and, therefore, may significantly contribute to overall fuel conservation. In FY 1976, using simulators resulted in a savings of 1.3 million barrels of JP-5 (5.1 percent savings), which was valued at $37.5 million.

The Air Force has initiated aircraft conservation research and development for fuel consumption. There will probably not be a conservation payoff from research and development improvements in the next 20 years.

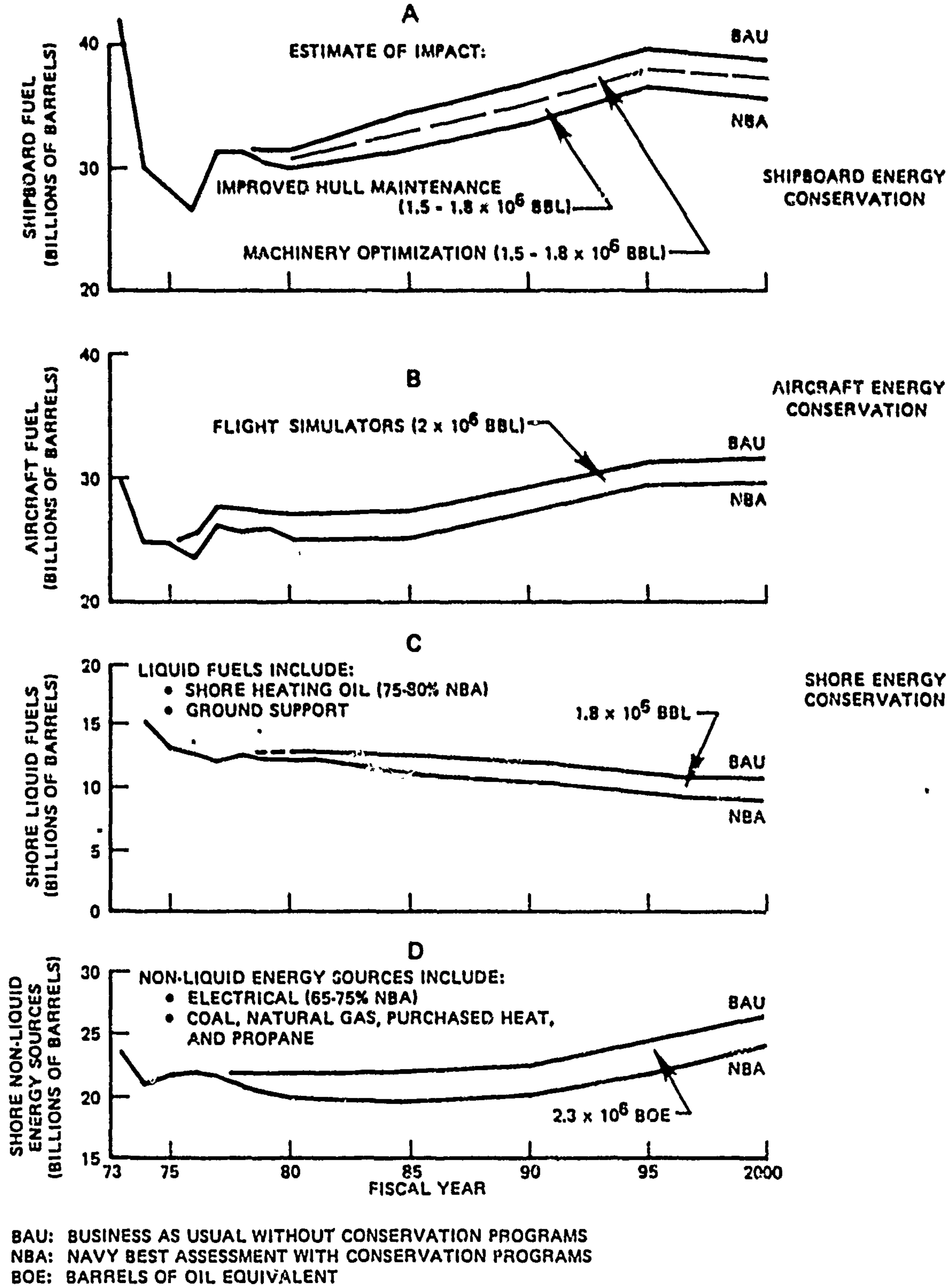


Figure 6-3. LONG-TERM IMPACT OF NAVY'S CONSERVATION PROGRAMS

6.2.2.3 Shorebased Energy Conservation

The NAVFAC energy engineering program will reduce the demand for fuel oil and for nonliquid fuels based on shore facilities with a near-term fuel conservation payoff by FY 1985. The conservation impact on shore facilities is based on projections that were adjusted to accommodate higher activity levels to support the increased OPTEMPO levels expected by ships and aircraft (fuel conserved by ships and aircraft will probably result in increased OPTEMPO). As facilities and new improved heating and total energy systems replace outdated systems, additional conservation gains may occur. However, the life cycles of most of the systems currently installed may be well over 20 years. Consequently, as shown in Figures 6-3 (C and D), the near-term conservation program (fuel savings) will probably stabilize between 1985 and 2000.

6.2.2.4 The Impact of Navywide Energy Conservation

Figure 6-4 shows total fuel consumption, and, in turn, the total impact of the Navy's conservation programs. The probable growth in force strength will gradually offset the effect of conservation measures resulting in a new net increase in fuel demand to FY 1995, and a smaller additional increase to FY 2000. The Navy's combined conservation programs will produce savings equal to 9.6 million barrels of oil, or about 10 percent of Navywide fuel demand by FY 1995.

6.3 SYNTHETIC FUELS SOURCES

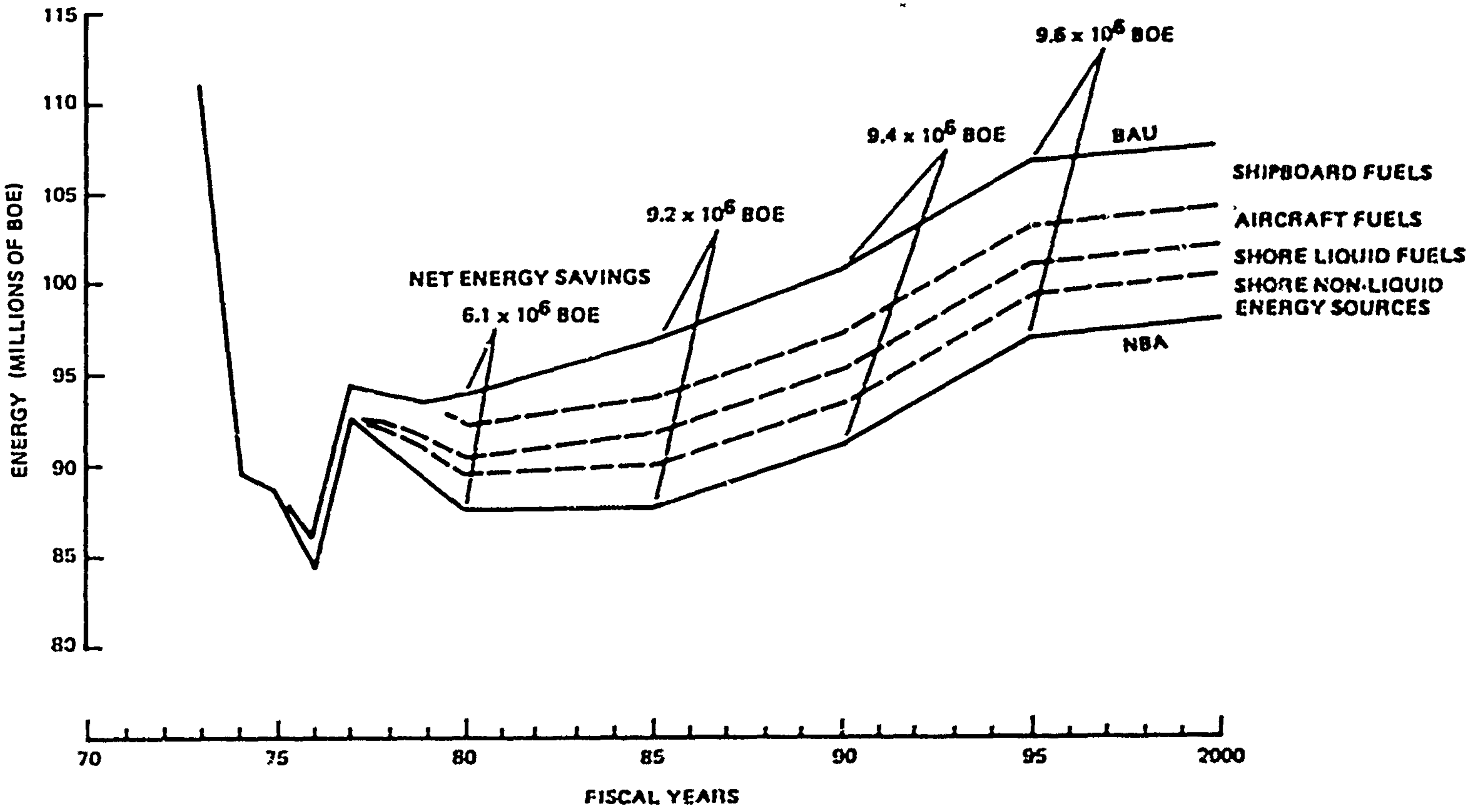
6.3.1 Possible Alternative Fuels for the Navy

The research and development community has investigated possible alternatives for petroleum-based fuels for ships and aircraft. Potential alternative fuels include: hydrogen, methanol, nuclear, and synthetics.

Hydrogen has some advantages as a transportation fuel. It has a high-energy value per pound (51,000 Btu/lb vs 17,000 Btu/lb for typical hydrocarbons), efficient non-polluting combustion properties, and it can be synthesized from water and other available energy sources. However, these advantages are offset by its low-energy density (29,600 Btu/gal vs 99,100 Btu/gal for typical hydrocarbons) and the low temperature at which hydrogen must be stored in liquid form. Tanks storing hydrogen would have to be insulated and be about four times greater in size than those holding a similar quantity of energy in hydrocarbon form. Studies by General Electric[1] and NSRDC conclude that using liquid hydrogen for ships and military aircraft is not technically and economically attractive, at least not in the next several hardware generations.

Methanol was also considered as an alternative fuel, since it can be manufactured from coke, coal, wood, and municipal waste. Unlike hydrogen, methanol can be stored in liquid form at normal temperatures. However, the energy density of methanol does not

[1] Berkowitz, B. et al, "Alternative, Synthetically Fueled Navy Systems: Force Element Missions and Technology," DDC No. AD/B-001 4011, General Electric Company–TEMPO, November 1974.



BAU = BUSINESS AS USUAL WITHOUT CONSERVATION PROGRAMS
NBA = NAVY BEST ASSESSMENT WITH CONSERVATION PROGRAMS
BOE = BARRELS OF OIL EQUIVALENT

Figure 6-4. THE LONG-TERM IMPACT OF SYNTHETIC FUELS favorably compare with JP-5, diesel marine, or gasoline because it contains less than one-half the Btus per pound or Btus per gallon. Thus, because of its low-energy density, methanol is neither a practical fuel for aircraft nor for ships, since it would require very significant increases in ship size to achieve the same range and payload performance.[3]

Nuclear-powered ships can transit at high speed over long distances without mobile or enroute refueling support. Also, on a life-cycle cost basis, large nuclear-powered ships can be economically competitive with their petroleum-fueled counterparts. Congress, in its defense authorization bill for FY 1975 (Public Law 93-365), specified that all future major combatant ships will be nuclear-powered unless the President determines that it is in the national interest to build ships with conventional propulsion systems. Nuclear propulsion has not been developed for smaller displacement surface ships or for high performance weight-limited craft. Although lower, specific weight nuclear power plants (that is, high temperature, gas cooled reactors) are possible, none have been developed. Before light-weight nuclear power systems are installed on small- and medium-size craft, considerable research in ship design and construction is necessary to ensure proper propulsion plant support and survivability.

Thus, for technical and economic reasons small and medium-size surface ships will continue to be nonnuclear, at least for the near future.

Synthetic fuels derived from coal, oil shale, and tar sands were also examined as a possible alternative fuel for the Navy. U.S. deposits of coal, oil shale, and tar sands are tabulated in Table 6-1. If properly developed, these resources could sustain projected U.S. petroleum demands for more than a century. Conversion technologies for producing liquid products from oil shale and coal have been demonstrated in small prototype operations. A commercial tar sands plant is in operation in Canada. Active research and development programs could improve the conversion process and reduce the cost of synthetic fuels. Using synthetic fuels rather than other alternative fuels such as hydrogen and methanol eliminates a substantial logistics problem that would occur with maintaining two different fuel supply systems during the 25 to 30 year transition period. Thus, synthetic fuels derived from coal, oil shale, and tar sands offer the best long-term assurance of available fuel for the Navy from nonnuclear domestic resources.

Table 6-1. SUMMARY OF U.S. ULTIMATELY RECOVERABLE ENERGY SOURCES
(Billion barrels of oil equivalent)

Energy Source	Resources
Crude oil	125
Natural gas	135
Coal	14,500
Shale oil	1,060
Tar sands	16
Total	15,836

[3] Bowen, T. L., "Investigation of Hazards Associated With Using Hydrogen As a Military Fuel," NSRDC/Bethesda, Report 4541, August 1975.

The Navy's continuing cooperation with ERDA in shale oil development should ensure that refined synthetic fuels will be available in the future. The national program to develop oil shale calls for a demonstration plant to produce about 100,000 barrels per day by 1985. The national goal of 1 million barrels per day by 2000 is a maximum figure and very optimistic. Figure 6-5 shows a possible apportionment of future shale oil production. This would offset the increasing demand for petroleum derived fuels that has been estimated to occur between the late 1980s and 2000.

In conclusion, only nuclear and synthetic hydrocarbon fuels can replace petroleum-derived fuels before 2000. Since most ships and aircraft have relatively long life-times (because of economic necessity), and since nuclear power is only planned for submarines and large surface ships, liquid hydrocarbons will continue to be the primary fuels required by the Navy's aircraft and most surface ships through 2000.

One of the criteria used for judging alternative energy sources for propulsion is life-cycle cost analysis (including amortization of research and development and support facility costs) of a nuclear-powered ship compared with an equivalent oil-fueled ship of the same military worth. Quantitative analysis is difficult because of the uncertainties of future fuel costs and the relative benefits and disadvantages of variations in logistical support needs in actual war.

6.3.2 Summary of the Applications of Synthetic Fuels in the Navy

The implication involved in the nation's depleting supply of natural petroleum is that the Navy must make the transition from natural petroleum to synthetic liquid hydrocarbons.

For technical and economic reasons, small- and medium-size surface ships will continue to be nonnuclear, at least for the near future.

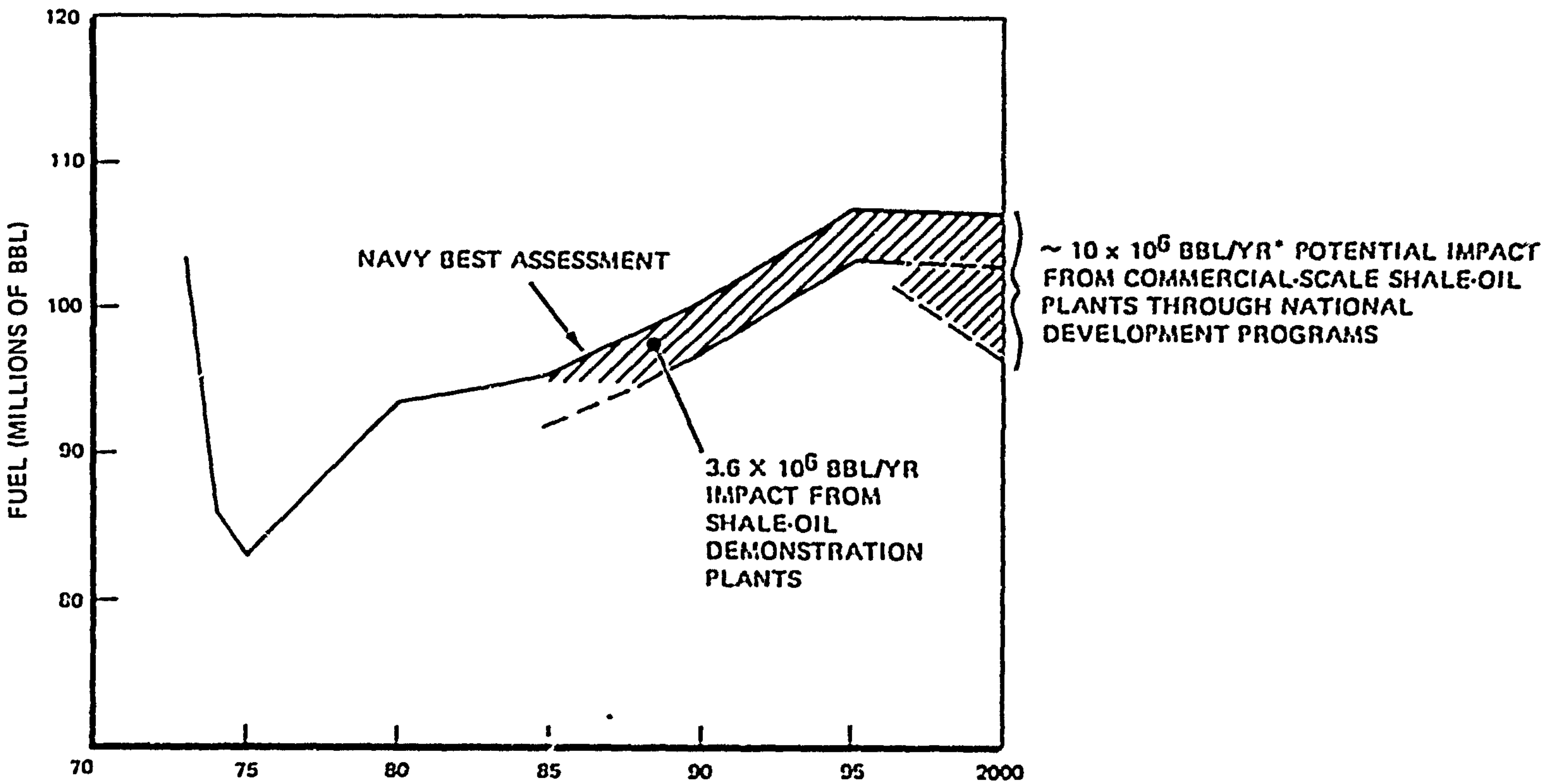
Evaluating other alternatives shows that:

- Using liquid hydrogen for ships and military aircraft, at least for the next several hardware generations, is not technically or economically attractive.
- Methanol, because of its low-energy density, is not a practical fuel for aircraft or ships.

Synthetic fuels derived from coal, oil shale, and tar sands offer the best long-term assurance of available fuel for the Navy from nonnuclear, domestic resources.

The cost in shifting to synthetic fuels is difficult to predict, given the implications of increased competition for remaining natural petroleum fuel resources and the effect on price.

Significant testing must be conducted for trace contaminants, storage, health effects in handling, and engine performance.



*THESE AMOUNTS ARE BASED ON A 10 PERCENT APPORTIONMENT TO THE NAVY FROM NATIONAL PRODUCTION PLANS

Figure 6-5. THE LONG-TERM IMPACT OF SYNTHETIC FUELS FROM OIL SHALE ON THE NAVY'S USE OF PETROLEUM FUEL

6.4 ENERGY SELF-SUFFICIENCY

6.4.1 Overview

The self-sufficiency strategy is to use local, renewable energy resources at remote and domestic bases. NAVFAC is investigating: solar heating and cooling, solar desalinization for the Navy's bases, small-scale and large-scale wind generators, solar (thermal) electric power systems, photovoltaic power systems, geothermal energy for the Navy's bases, waste and refuse energy sources, low-temperature heat-recovery systems, and total/selective energy systems. These projects will be conducted under CEL direction with the support of the Naval Weapons Center (NWC). There will be feasibility and preliminary design studies in each technical area followed by detailed designing, constructing, and testing of demonstration units. Initiatives before FY 1977 centered on exploratory development. In FY 1977, selected programs will be initiated at the advanced development stage.

6.4.2 Energy Self-Sufficiency of Remote Bases

Being able to use local energy sources at the Navy's remote bases is important, particularly during crises. The Navy's early energy self-sufficiency studies of remote forces and bases stressed the need to develop new formulas to evaluate the costs/benefits of new energy technologies to achieve this goal. The new formulas should first consider the strategic and tactical value of not depending on the energy pipeline. Second, the new formulas should consider that the Navy's traditional fuel pipelines have premium transportation and handling costs associated with them during a war that includes storage costs and protecting forward areas. These important considerations should play a significant role in the Navy's long-term planning. Choosing energy forms might be different if these costs were properly quantified and added into a life-cycle cost formula.

Studies show that the energy self-sufficiency of all remote bases is an elusive goal. Some bases exist primarily to support the Navy's ships and aircraft. An essential part of this support involves dispensing quantities of fuels on a much larger scale than the quantity of fuel or other energy consumed by the base itself. Thus, having a local energy supply for the base does not really make the base self-sufficient. An indigenous energy supply for local consumption does not substantially reduce POL base requirements, except for truly remote bases (often communications stations) where consumption is dominated by local energy use.

Generally, there could be truly self-sufficient remote bases when operating forces, supported by the bases, are replaced by nuclear-powered ships. The need for aircraft support will remain for the future. Today, ship investments and the need for small ships not suitable for nuclear power establish a major POL requirement, in addition to aircraft support, for a period beyond the present DOD planning cycle.

In the interim, using local energy, rather than on-site fuel from storage, is basically an economic trade-off between the cost of applying local energy sources and purchasing, transporting, and storing conventional fuels. However, future plans should be heavily biased in favor of using local renewable sources to conserve fuel resources and to achieve the self-sufficiency of forces in the long-term. When opportunities to use renewable sources are identified, substantial economic justifications for not exploiting them should be required.

The Navy's installations are frequently a microcosm of civilian society, that is, a blend of household and industrial energy use. Thus, they may offer a unique opportunity to serve as test centers for energy concepts which, because of their developmental stages and/or limited production, have not yet proven to be commercially economical.

6.4.3 Energy Self-Sufficiency of Domestic Bases

Conforming to the national solar demonstration program, selected Naval bases should be considered for solar heating and cooling. The Navy's installations near known geothermal resource areas should also be examined for geothermal steam production for heating or power production. Renewable energy resources that could be applied to any of the Navy's bases should be studied to match significant portions of each base's yearly energy demand requirements. Analytical procedures could be used to conduct preliminary technical and economic evaluations of various alternative self-sufficiency projects for test bases. Alternatives should include multiple self-sufficient subsystems such as waste heat recovery to supplement solar heating.

6.4.4 The Navy's Future Efforts in Energy Self-Sufficiency

Generally, energy self-sufficiency projects have long-term payoff periods. For instance, a solar heating system may need 20 or more years in fuel savings returns to offset the initial expense. The value of these systems is difficult to assess, since their reliability is questionable and economic projections are highly subjective. Reliably assessing performance may be easier in another five or ten years after empirical testing and evaluating of new technology has taken place.

Consequently, the Navy's benefits that are obtained from these advanced systems may not be realized before 2000. Therefore, these projects depend on the Navy's initiative in long-range planning, since each project will be continually compared to other more short-term payoff programs. Energy self-sufficiency projects may have difficulty surviving future budget adjustments.

The Navy should maintain a reasonable level of investment in energy self-sufficiency research and development to support long-range payoff projects. Although these projects are low-priority, they should be supported after carefully evaluating their future benefits.

Because the self-sufficiency research and development program will receive a relatively low investment priority, test bases must be carefully selected to produce cost-effective demonstration projects that offer the promise of results in the short-term. Thus, the most cost-effective projects can be identified and priorities assigned. Limited research and development funding can then be allocated to produce a maximum return on investment.

To ensure that remote bases are self-sustaining, in case normal fuel supplies are interrupted, the Navy should consider having remote bases store at least a 30-day fuel supply.

6.5 ENERGY DISTRIBUTION, ALLOCATION, AND STORAGE

6.5.1 Overview

Today, available programs under the energy strategy provide an effective and responsive fuel storage and distribution network. Requirements have been developed for the Navy's wartime operations through the PWRMR program and POL allocation has been assigned. Present stock levels are adequate to support needs. Although the required amount of tankage is available, all of it is not in appropriate locations. Subsequently, there is a certain malpositioning of stocks.

A new PWRMR methodology is being developed that could significantly change needs in certain geographical areas. Therefore, it is possible that a greater degree of malpositioning of bulk stocks will take place in the near future. Preventive measures must be taken soon to prevent degradation of wartime readiness. Today, the Navy can adequately distribute these stocks in peacetime (AOs, MSC tankers, etc.).

6.5.2 POL Supply and Storage System

A worldwide supply and storage system furnishes POL stocks to use during peace and war. The worldwide Navy storage system functions adequately, but it requires substantial dollar resources for new construction and for repairing and upgrading present facilities. The system is flexible and has adapted to two changes in the Navy's basic fuel in the past few years: the first change was from NSFO to ND, and the second change was from ND to DFM. If synthetic fuels become the major source of the Navy's fuels in 1985 and beyond, there must be considerable testing of the storage compatibility of these fuels (natural petroleum fuels mixed with synthetic fuels).

6.5.3 Reporting and Monitoring Systems

DOD has evolved an accurate system for obtaining basic consumption and inventory information on ships and shore facilities. The DEIS-I and DEIS-II reports were developed to fill a long-standing void in POL reporting and responsibility. The fleet commands, using DEIS, have initiated their own reporting systems. They are more detailed than the DEIS and provide an allocation, fiscal, and monitoring capability not previously available. The reports and final accounting system have given the DOD and the Navy the proper tools for developing an effective fuel management system.

6.5.4 Pollution Control

The Federal Clean Air Act and subsequent state and local emission regulations have generally set strict emission limitations. Regulations on emissions from fuel burning operations mean controlling the sulfur and ash content of fuels where adequate stack cleaning equipment is not available to remove particulates from stack gases. Low-sulfur and low-ash fuels are not abundant, and thus are expensive. Neither the Navy nor commercial electrical producers who supply the Navy can switch from oil or gas to coal or economical low-grade fuel oils unless expensive stack gas cleaning equipment is installed. The overall impact will reduce the flexibility of fuels for the Navy's installations and increase the cost of the Navy's utility power.

Vapor control regulations will mean installing special vapor control equipment on tankage. Retrofitting certain existing tankage may not be practical. The overall effect of vapor emission regulations will, therefore, be to further increase the cost of storing fuel for the Navy's use.

Converting to DFM as a standardized ship fuel presents a unique storage problem. In many tanks, there is profuse leaking or seeping through the porous concrete tank walls. These tanks had previously contained the more viscous NSFO, which had caused only minor seeping to the exterior. Leaking fuel is wasted, presenting a potential pollution problem that violates EPA regulations. Tanks that leak excessively are taken out of service, thus reducing war reserve stock levels. These tanks cannot be used until funding for lining interior surfaces is approved. Additional research using readily available lining systems is critical in assuring that all available tankage is in the proper condition.

Today, policy, contingency plans, and guidelines on environmental protection matters, in the event of a crisis (Arab oil embargo of 1973 or more serious crises) are not clearly identified in OPNAVINST 6240.43D. If this is covered in the National Defense Act, the OPNAV instruction does not clearly cite applicable measures.

The Navy must follow federal and local environmental and pollution control regulations. In some instances, the Navy's requirements are more stringent than local requirements. The Navy was at a definite disadvantage at the start of the environmental era because its ships were not built with antiwaste and antipollution measures. So, an intense and costly program was initiated to bring the Navy's ships and shore facilities up to government standards. Consequently, the Navy had to construct new tanks for waste POL products at virtually all its terminals. This program has just begun to produce savings and lessen the environmental impact in that the loss of POL products, due to survey stripping and unknown reasons, has been reduced drastically. These programs will probably continue until the Navy complies with all Federal environmental regulations.

Today, based on deficiencies that have been identified, the financial impact of these projects exceeds pollution abatement budget limitations. Accordingly, an Issue Paper has been submitted to be considered during the review process. This will precede the OPNAV POM for FY 1978. The purpose of the Issue Paper is to emphasize SPCC requirements and to establish a budget base within the pollution abatement program for funding corrective projects. However, budget and program limitations imposed by OMB circular A-106 dictate that only those SPCC projects that meet project qualifications will be considered for pollution abatement funding. NAVFACNOTE 6240, dated 28 January 1976, contains specific guidelines regarding eligible projects for pollution abatement funding.

6.5.5 POL Training

There must be a comprehensive and specialized training program for personnel assigned to fuel management and handling billets because there have been: increased fuel costs; GAO interest in controlling fuel discharges at sea; and introduction of JP-5 systems in surface combatants, other than aircraft carriers; more rigid quality control procedures of DFM compared with those for NSFO or NDF; and an addition of fuel system icing inhibitor to JP-5 stocks.

Developing a systems approach to fuel training for surface ships should be considered. An integrated training program should be developed for each ship class; for example, fast frigate with surface propulsion and aviation fuels. This approach would involve the coordinated efforts of all cognizant SYSCOMs.

6.6 ENERGY MANAGEMENT AND PLANNING

6.6.1 Overview

Energy management planning is included as a strategy because of the unique problems and conditions associated with energy development and the challenge of managing programs to cope with these developments. The time it takes to achieve results in energy program activities is an example. Many of the more promising solutions for energy problems will only have a significant impact years after the program managers have left. Consequently, criteria established to select alternative energy programs should be short-term, that is before "payback" of the original investment in the program. Although the payback criteria may be appropriate for screening energy program options in one of the Navy's organizations, other of the Navy's activities that face changing conditions may require other more suitable criteria for determining likely programs that offer the greatest energy benefits.

Another problem in energy management is the lack of accepted standards to assess on-going progress and the results that are achieved. Lacking agreement on energy equivalents for electric power units or determining what base year is used to calculate energy savings will make significant comparative assessments of energy programs difficult and their results inaccurate.

Although national energy planning will help alleviate some of the Navy's future energy supply problems, the national effort will not, nor was it intended to solve all the military energy problems. This presents yet another problem for the Navy's energy planning. Although relying on national energy planning and the Defense Production Act to provide the required fuels in a crisis simplifies budget and planning considerations—the Navy must be aware that supplying energy to remote bases, the fleet, and the Navy's aircraft poses unique problems that demand special attention, plus a great deal of time and planning.

6.6.2 Overall Energy Management and Planning

Although many individual components of the Navy are vigorously promoting energy programs and managing energy matters within their own spheres, they are doing so without a centralized approach, that is, the approach is decentralized and fragmented. To better coordinate the diverse energy efforts and to integrate the separate aims and intentions, a planning process is being implemented to cover all the Navy's energy interests. This constantly evolving planning process will help to ensure that ideas and direction relating to energy efforts are communicated, understanding is achieved, and managers are committed so that the Navy's energy situation can be significantly improved. An energy management planning strategy will meet these requirements and provide the framework so that goals become policies to carry out the Navy's mission under the new, tighter energy limitations that have been imposed.

Figure 6-6 describes in greater detail the energy planning process as it is being developed in the Navy. The criteria used to select various program alternatives are shown on the chart. Traditionally, these criteria have been applied somewhat independently by separate components of the Navy. Without integrating these criteria to reflect the Navy's perspective on energy matters, a valid comparison of program results cannot be made and program value assessments cannot be carried out.

The key issue is not creating new program selection criteria or even changing the ones currently used, but, rather, it is to analyze the criteria already available and to focus on those that best describe the impact and benefits/costs. Criteria analysis should not be devised so that the problem is studied to excess, or that the administrative burden becomes unacceptable. Also, it must be understood that policy analysis of energy matters may necessitate a fresh approach in applying each criterion. Thus, it is concluded that centralized energy policy options can be developed, evaluated, and continually selected in an on-going process of energy planning, at a minimum cost, and with significant direct benefits.

Figure 6-6 also shows the link between selecting criteria and various energy program functions such as identifying programs, funding approval, and implementing and evaluating programs. All this will be input to the Navy's energy planning to determine objectives and policies. The chart also depicts principal inputs to each of the program functions.

Figure 6-6 also shows the planning process. However, it is not intended to supersede the Navy's traditional planning procedures such as the Programming Manual, OPNAV 90P-1D. The Navy's approach to energy planning is to incorporate traditional practices into a more suitable framework to solve long-term energy problems. Unfortunately, today's energy problems will take decades to solve. Therefore, it is necessary to supplement the FYDP with more long-range planning. The Navy's energy plan will accomplish this.

The need for long-range energy planning is best illustrated by examining DOD's present energy policy concerning energy consumption goals. Today, the goal for FY 1977 is level consumption as compared with FY 1975. Long-range goals are not provided for

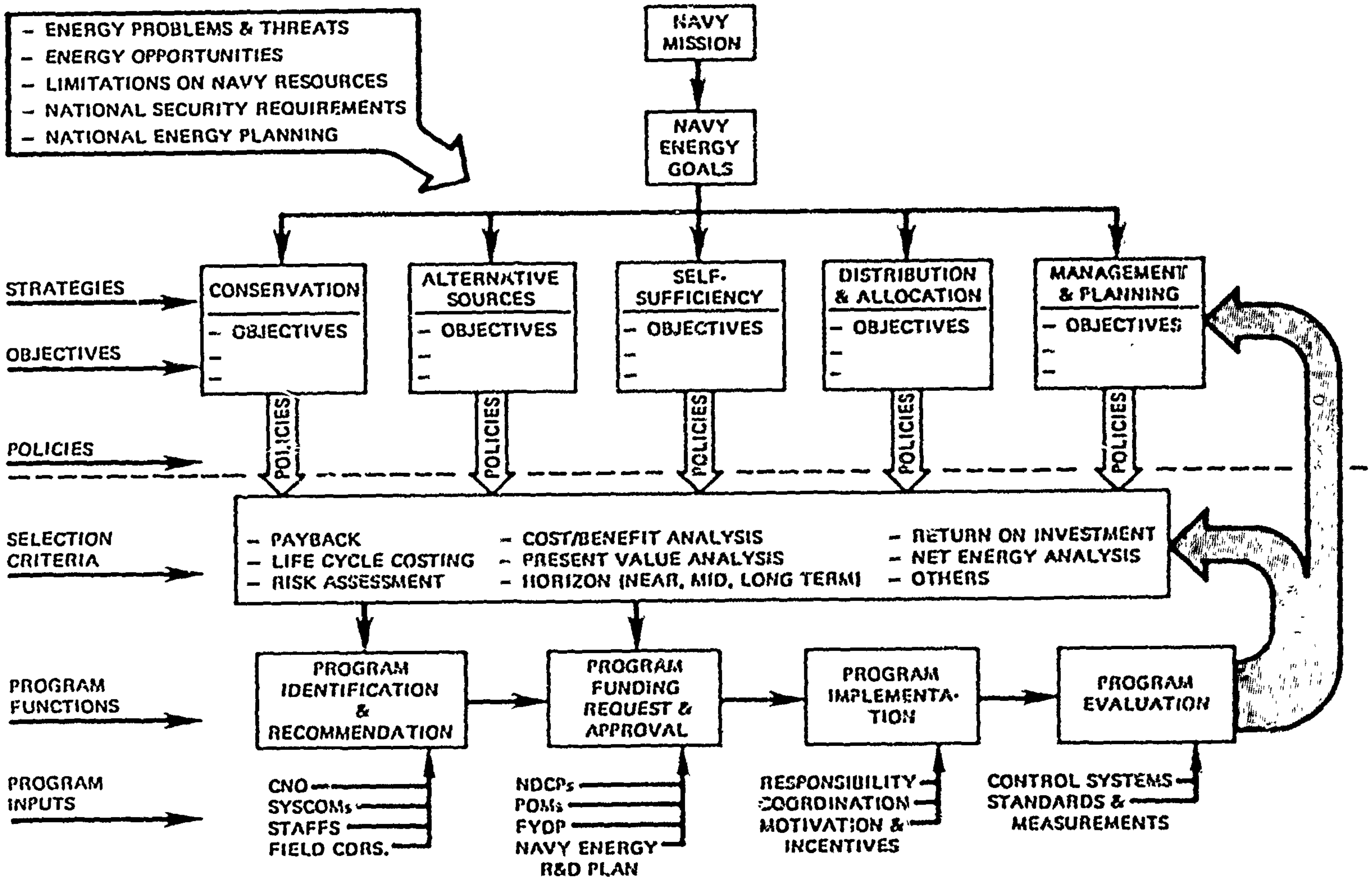


Figure 6-6. NAVY ENERGY PLANNING AND PROGRAM ACTIVITIES

FY 1978, or even FY 1979 to the services by DOD. Continually applying zero growth in consumption prior to the time where energy payback will occur from energy capital investment programs is essentially a policy to reduce OPTEMPO to keep consumption down in the short-term.

6.6.3 Budget Impact of the Navy's Energy Programs

The cost of the Navy's energy programs can best be estimated from the proposed budgets submitted by the major program offices. The Navy Energy and Natural Resources Research and Development Plan is coordinated by MAT-03Z. Consequently, the overall cost of this program can be determined from the POM 78 and NDCP budgets that were submitted. NAVFAC's energy engineering program (primarily ECIP) is supported through military construction funds (MILCON and O&MN) by NAVFAC (FAC-05). Modernizing POL facilities is under NAVSUP and is also budgeted under MILCON (and some O&MN) funds.

The individual total programs are budgeted using different time intervals, and, therefore, there must be some estimates and assumptions to determine the Navy's total program budget between FY 1977 and FY 1981. Table 6-2 is a budget estimate for the Navy's overall energy program and is not an authorized or necessarily accurate budget breakdown. The budget breakdown indicates that the primary emphasis is on ECIP. This is appropriate, since the projects selected in the ECIP program must meet a near-term investment payoff of six years. The near-term fuel conservation impact of the ECIP projects could be significant when they become widely used by the Navy's bases.

Table 6-2. NAVY ENERGY PROGRAM BUDGET ESTIMATE FOR FY 1977 TO FY 1982 (Millions/cumulative)

Energy Research and Development (6.2 through 6.5)	$158
NAVFAC Energy Engineering	
ECIP	303
Energy Engineering	30
Modernizing POL Facilities	49
Total	$540

The energy research and development program is multifaceted and involves testing and evaluating synthetically derived fuels, self-sufficiency projects, and near-term and far-term conservation projects. Energy research and development is trying to achieve mid-term and far-term payoffs. It will be important to expand future energy options and reduce long-term energy costs.

Although modernizing POL facilities is a low budget priority, it requires constant review as current facilities age, become obsolete, or inadequate. The budget estimate does not include environmental protection costs, which are not considered as directly energy-related.

The cumulative Navywide cost of energy between FY 1977 and FY 1982 will be well over 10 times the FY 1977-FY 1982 budget estimate for the Navy's energy program. This investment is marginal compared with the much greater and continually increasing cost of the expected energy demand levels.

7.0 THE NAVY'S FUTURE ENERGY POLICY

7.1 INTRODUCTION

Developing the Navy energy plan, which sets forth the Navy's overall energy objectives and establishes the Navy Energy Office within OPNAV, has provided a foundation and framework for future energy analysis. The continually evolving energy policy within the Navy will require studying and analyzing specific questions that the CNO Energy Action Group (EAG) considers appropriate or necessary to evaluate program alternatives.

This section lists a few selected questions that could be considered. The Navy Energy Office is responsible for further review, and will also recommend to the EAG what questions should be analyzed in detail.

7.2 SELECTED ENERGY POLICY QUESTIONS FOR REVIEW

General

What is the quantitative relationship between fleet peacetime operations, readiness, and energy inputs?

Supporting the Navy from CONUS

What is the impact of cost and tanker requirements on supporting the Navy's fuel needs (worldwide) from domestic sources?

Petroleum Reserves

How will availability of Alaskan North Slope petroleum to the Pacific Fleet affect the Navy's worldwide distribution system with regard to cost and tanker needs?

Differences in Fuel Consumption Rates

What are the reasons for large differences in fuel consumption rates for certain classes of ships in the Atlantic and Pacific Fleets?

Synthetic Fuels

What would be the value to the Navy of having synthetic fuels, refined in the interior of CONUS, available for the Navy at various coastal locations?

Losing Sources and Routes

What would be the impact on the Navy's distribution system if selected POL sources and distribution routes were lost? Of special interest are the Persian Gulf countries, Venezuela, Indonesia, and other world locations that the United States heavily depends on for crude oil.

Research and Development

What would be the effect on the Navy's distribution system if fuel consumption were reduced by 20 percent (suggested goal) in a specified class of ships?

Fuel Budget

Will an energy distribution model support or improve the Navy's estimate of its annual fuel budget?

POL Stockpile Requirements

What stockpiles (amount and location) would be required to satisfy the Navy's POL demands if sources were cut off for a time and/or if tanker availability were limited?

Improve Distribution System

What would be the impact on the Navy's distribution system if supertankers and associated systems such as deep water ports, buoys, etc. were used?

Conventional/Nuclear

What would be the value to the Navy (in terms of reducing delivered fuel costs and tanker requirements) of having a combination of specified classes of the Navy's ships designated conventional and/or nuclear?

Standardized Fuel

What would be the value to the Navy of having one fuel for ships and aircraft?

Strait

What would be the impact on the Navy's distribution system if territorial waters were extended to (for example) 12 nautical miles?

What would be the effect on the Navy's distribution system if the Strait of Malacca were closed?

Losing Forward Area Sources

If Seventh Fleet units were denied fuel from all nearby sources, what would be the impact on the Navy's worldwide distribution system? How much time would it take for the system to adjust to the denial?

Buildup in Mediterranean

What would be the impact on the Navy's distribution system (at the *system* level) if naval forces in (say) the Mediterranean area were increased and forces elsewhere in the world were decreased?

Desirable Refining and Storage Locations

Using various scenarios in which it is assumed that CONUS and/or the overseas capability for refining and storing the Navy's POL must be increased, what geographical locations are most advantageous to the Navy?

Using Very Large Crude Carriers (VLCCs) for Floating Storage

How will the Navy's POL storage (amount and location) have to change to make up for losing storage in an area where the United States is politically vulnerable, for example, Japan?

For postulated changes in the fixed storage system, how should the system be augmented with suitably configured VLCCs to be used for floating storage to meet specified increases in demand because of a military crisis?

What happens between the time a crisis begins (where VLCCs are not deployed) and the time VLCCs replace each other as their POL is consumed? How soon must VLCCs be able to arrive "on station" for postulated fixed storage? What is the cost of systems with varying amounts of fixed storages and varying degrees of VLCC "readiness"?

System Costs for Two Different Procurement Policies

What is the most advantageous policy for managing MSC assets: to minimize the total product and transportation costs, or to maximize the utilization of dedicated (MSC-owned plus long-term lease) tankers?

Should the Navy support any change in existing restrictions on using MSC tankers?

Minimal Tanker Requirements

What are the minimal tanker requirements for available worldwide POL? What increase in system cost results from using the minimal-tanker distributions as compared with minimum cost distributions?

As a special case, what are minimal tanker requirements for supplying the Navy worldwide from CONUS, assuming there is either unlimited or limited available POL at all CONUS sources?

Protecting Lines of Supply

During crises, when tankers are considered vulnerable to submarine or surface ship or air attack, how should the Navy change its POL distribution to either minimize its vulnerability to detection or attack by the enemy?

Most Economical Speeds

What are the most efficient and economical speeds to use for the various classes of ships in the U.S. fleet?

Use of Training Simulators

What is the effect of increasing the use of training simulators as an alternative to on-the-job training?

APPENDIX A

PATTERNS OF ENERGY USAGE IN THE U.S. NAVY

APPENDIX A

PATTERNS OF ENERGY USAGE IN THE U.S. NAVY

INTRODUCTION

Inherent in the planning and evaluation of Navy energy policies and objectives is the need for an accurate and Navy-wide system to collect, verify, and display energy usage data. The Navy Energy Usage Profile and Analysis System (defined in Appendix B) was designed for this purpose. Development of the initial data base, FY 1973-74, required some extrapolation, which is discussed in this appendix.

METHODOLOGY OF DEVELOPMENT

The overall approach to develop the patterns of energy usage in the U.S. Navy has been to gather energy usage and activity level data for naval ships, aircraft, and shore facilities; sort these data by appropriate consumer function, type, and energy form; and sum the data through appropriate subtotals to a final overall Navy total. Because of input constraints, some estimates were made to provide a more complete Navy-wide presentation, but these estimates represent less than 2 percent of the total. Figure A-1 is an example of how the Profile Analysis System can look at each consumer platform.

Ship energy usage data gaps were encountered where individual ships occasionally failed to submit a monthly report. Such gaps were bridged, where appropriate, by deriving the average monthly fuel consumption and steaming hours rate for the months reported and applying this average over 12 months. The number of reports involved in this process was less than 2 percent of the reports filed.

Fuel consumption by Military Sealift Command (MSC) operated ships was obtained from MSC headquarters for FY 1973-74 and from the Defense Energy Information System (DEIS) I report for FY 1975-76. Although the total fuel usage by dry cargo ships in FY 1973 was specified by MSC headquarters, its distribution by fuel type was not available This was estimated from FY 1974 data to be 61 percent, Navy special fuel oil (NSFO); 20 percent, No. 6; 17 percent, diesel; and 2 percent, Navy distillate (ND).

Fuel consumption by ships chartered by MSC was obtained from the Defense Fuel Supply Center's fuel terminal report files for FY 1974-75. These data were a compilation of the amounts of fuel issued to commercial ships and billed to MSC. The compilation was limited to the fuel terminals at Subic Bay, Yokosuka, Guam, Pearl Harbor, Rodman, and Rota on the advice of MSC headquarters. Since detailed data were not available for

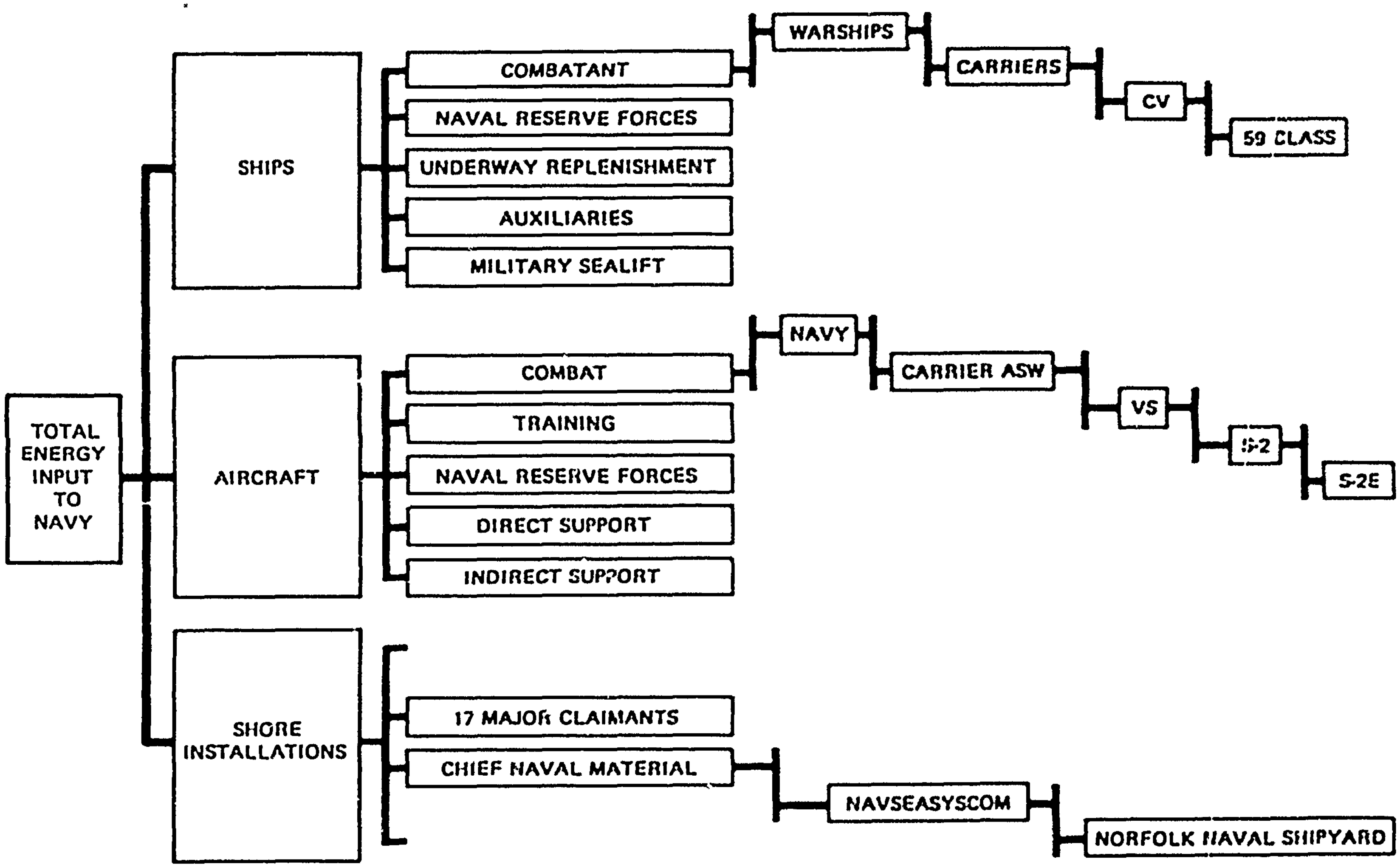


Figure A-1. U.S. NAVY ENERGY PROFILE FORMAT

FY 1973, fuel consumption for that period was estimated, based on FY 1974 reports and MSC guidance, to be 1.5 million barrels.

Aircraft energy usage covers the total usage by all Navy and Marine Corps aircraft. Energy usage was calculated from total flying hours and aircraft type fuel consumption rates. Flying hours were sorted by function and aircraft type and the appropriate hourly fuel consumption rate was applied. The consumption so calculated was summed through aircraft types and functions to an overall aircraft total.

Shore facilities utility energy usage was compiled by the Naval Facilities (NAVFAC) Engineering Command headquarters. FY 1973-74 usage was compiled from the Reduced Energy Consumption Report and FY 1975-76 usage was compiled from the DEIS-II reports. The data were sorted by major claimant and energy type and summed to an overall facilities utility energy usage total. The results presented for FY 1973, FY 1975, and FY 1976 are worldwide totals. FY 1974 data, however, were collected only for the 50 states. Overseas utility energy usage for FY 1974 was obtained from an earlier study of facility energy usage done by David W. Taylor Naval Ship Research and Development Center (DTNSRDC). These data were added by energy form to the NAVFAC results to give worldwide totals. Sufficient detail was not available to divide the overseas usage by major claimant.

Energy used by shore installation ground support equipment was not accumulated by NAVFAC. Ground support data available from an earlier NSRDC study, however, were not considered reliable. FY 1973 baseline data were taken from an analysis of DEIS-I. The FY 1974 usage was estimated by scaling up the DTNSRDC FY 1974 data by the ratio of OP-413's FY 1973 data versus DTNSRDC's FY 1973 data. Ground support energy usage in FY 1975-76 was taken from the DEIS-I reports.

Navy energy costs were calculated by several means. Ship and aircraft fuel costs were derived by multiplying computed fuel usage by the average cost of each fuel for the fiscal year. The usage rate was assumed to be constant throughout the year for ease of calculation. In reality, usage rates vary. It was believed there would be no significant error introduced by this method. Shore energy costs for FY 1975-76 were provided by NAVFAC. Shore costs for FY 1973-74 were calculated from average costs per energy type and the amount of each energy type used as supplied by NAVFAC.

ENERGY CONVERSION FACTORS AND AVERAGE ENERGY COSTS

Table A-1 shows the conversion factors used in the energy profile system. Because the heating or thermal value of a fuel is related to its API gravity, an average value for each fuel type was used. This average value is being revised based upon procurement distribution patterns of the Defense Fuel Supply Center.

Table A-2 shows the average cost to the Navy of each energy form for the fiscal year.

Table A-1. ENERGY CONVERSION FACTORS

Energy Form	Quantity Unit	Btu[a] per Quantity Unit
Automotive gasoline	bbl[b]	5.25×10^6
Aviation gasoline	bbl	5.25×10^6
Jet fuel, JP-4	bbl	5.34×10^6
Jet fuel, JP-5	bbl	5.67×10^6
Kerosene	bbl	5.67×10^6
Diesel fuel	bbl	5.83×10^6
Distillate fuel oil, No. 2	bbl	5.83×10^6
Navy distillate fuel oil (ND)	bbl	5.95×10^6
Navy special fuel oil (NSFO)	bbl	6.22×10^6
Residual fuel oil, Bunker C	bbl	6.29×10^6
Propane	gal	95,500
Natural gas	SCF[c]	1,031
Coal, bituminous	short ton	24.58×10^6
Steam	lb	1,000
Electricity[d]	kwh	11,600
Barrel of oil equivalent (BOE)[e]	bbl	5.8×10^6

[a]British thermal unit (Btu)
[b]1 barrel (bbl) = 42 U.S. gallons
[c]Standard cubic foot (SCF)
[d]FEA value—includes energy expended in the production and transmission of 1 kilowatt hour
[e]1 million BOE = 10^6 BOE

Table A-2. AVERAGE NAVY ENERGY COSTS

Energy Type	FY 1973	FY 1974	FY 1975	FY 1976
Petroleum fuels (dollars per barrel)				
AVGAS	7.350	12.190	17.387	19.257
MOGAS	6.160	9.520	15.358	17.199
JP-4	5.103	9.307	15.400	16.611
JP-5	5.173	9.409	14.700	16.023
DFM	4.900	9.037	14.350	15.309
ND	4.252	9.116	14.659	15.309
NSFO	3.078	7.672	13.759	14.164
Shore heating oil	4.470	8.700	12.880	13.340
Average petroleum[a]	4.458	9.054	14.394	15.959
Electricity (dollars per kilowatt hour)	1.253	1.844	2.436	2.568
Natural gas (dollars per million Btu)	0.610	0.720	0.930	1.230
Propane (dollars per million Btu)	--	--	3.280	4.060
Coal (dollars per ton)	21.320	26.460	38.960	35.040
Purchase heat (estimated dollars per million Btu)	1.177	2.148	2.880	3.010

[a]Average computed on basis of BOEs used of each fuel type.

ENERGY UTILIZATION COMPARISON (FY 1973 to FY 1976)

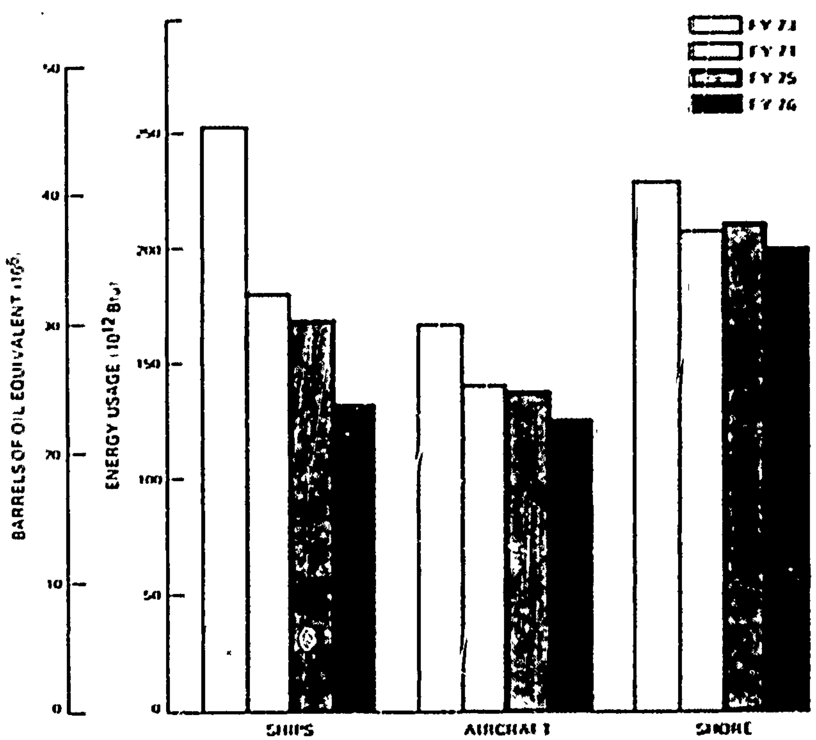
As shown in Figure A-2, the Navy realized a total energy reduction of 20.1 percent in FY 1974, 21.7 percent in FY 1975, and 29.9 percent in FY 1976, as compared with the baseline year, FY 1973. The greatest reduction was achieved by ships, which used 48.9 percent less energy in FY 1976 than in FY 1973. This reduction in energy usage was achieved in part by a reduction of total steaming hours. Naval aviation units achieved a 23.6 percent reduction in FY 1976, as compared with FY 1973. Flight hours in the same period, however, were reduced significantly. Naval shore facilities reduced their energy usage by 13.5 percent in FY 1976 from FY 1973 levels. There was no attempt to measure activity levels for shore facilities as there was for ships and aircraft.

In spite of the reductions in energy consumption, the cost of energy increased by 115.3 percent to $1.077 billion between FY 1973 and FY 1976 (Figure A-3). This cost is nearly evenly distributed among ship, air, and shore activities, 29.2 percent, 32.1 percent, and 38.7 percent, respectively.

Petroleum is the primary energy form used within the Navy, followed by electricity, natural gas, and coal in popularity. In FY 1976 455.0 x 10^{12} Btu's of petroleum were used, which was 72.8 percent of the total energy consumed by the Navy (Figure A-4). The various forms of petroleum energy usage and quantities used are shown in Figure A-5 and the corresponding costs in Figure A-6.

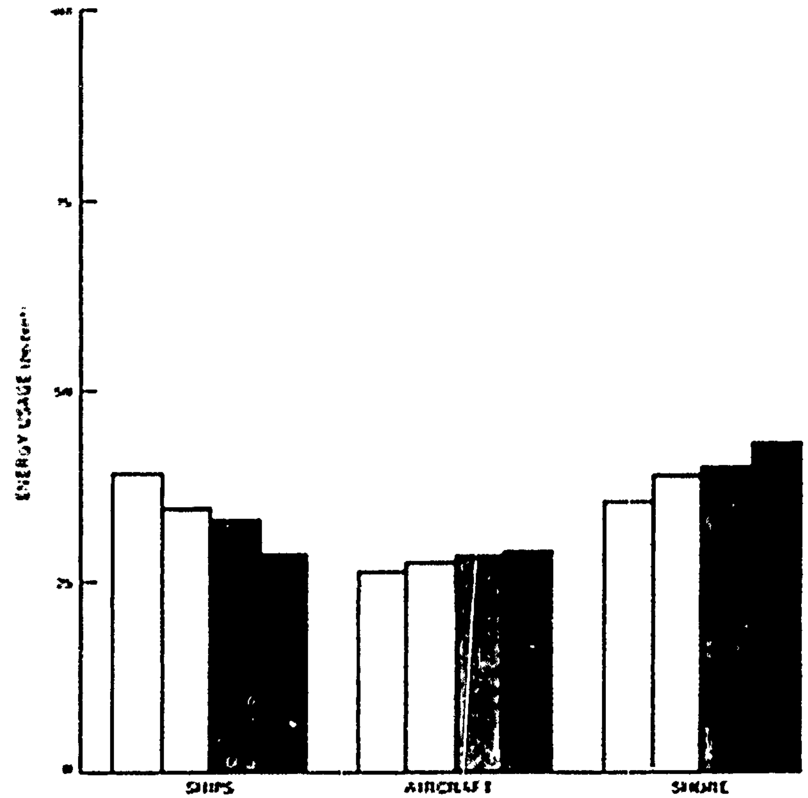
Detailed ship energy usage, ship petroleum energy usage, and ship steaming hours data through FY 1975 are provided in Figures A-7 through A-9. (FY 1976 data are not currently available.) Warships account for 55 percent of the total energy used in FY 1975. Diesel fuel marine (DFM) was the primary petroleum energy used in FY 1976, totaling 13.3 million barrels or 59.9 percent of the total. This is a significant change in the composition of petroleum usage from FY 1973 when DFM accounted for only 5.2 percent of the total and reflects the trend away from NSFO in an effort to reduce fuel types. The percentage of ship underway time decreased 32.6 percent from FY 1973 to FY 1976.

Figures A-10 through A-12 provide detailed aircraft energy usage data similar to the ship data. The amount of petroleum used by aircraft decreased by 23.2 percent between FY 1973-76 (Figure A-11), which is about equal to the percentage change in flight hours between FY 1973-76 (Figure A-12). Figure A-13 shows shore energy use by energy form.



ACTIVITY	ENERGY USAGE (10^{12} Btu)				CHANGE (percent)		
	FY 73	FY 74	FY 75	FY 76[b]	FY 73-74	FY 73-75	FY 73-76
SHIPS	251.5	179.8	160.0	130.1	29.4	33.6	48.9
AIRCRAFT	167.4	139.0	138.8	127.9	17.0	17.1	23.6
SHORE[a]	227.6	200.1	200.9	197.0	12.1	11.7	13.5
TOTAL	619.5	518.9	508.7	455.0	20.1	21.7	29.9

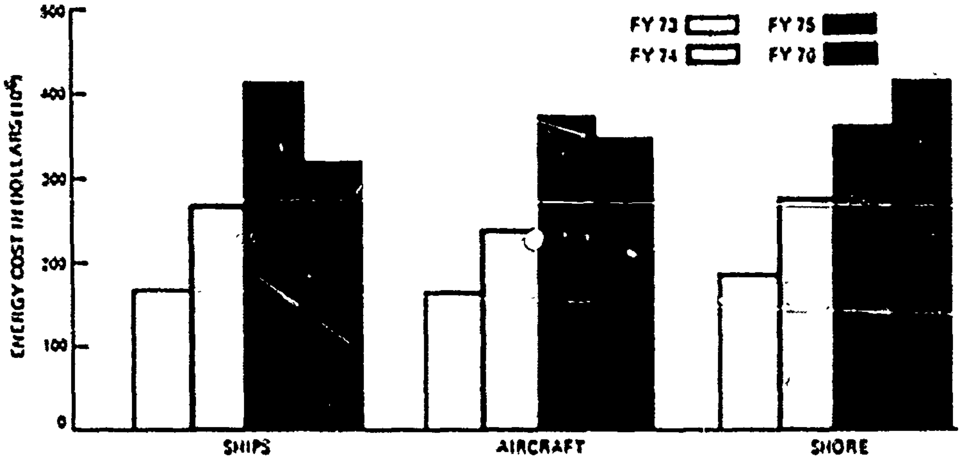
[a]INCLUDES UTILITIES AND GROUND SUPPORT
[b]PRELIMINARY DATA



PERCENT COMPARISON BY ENERGY USAGE

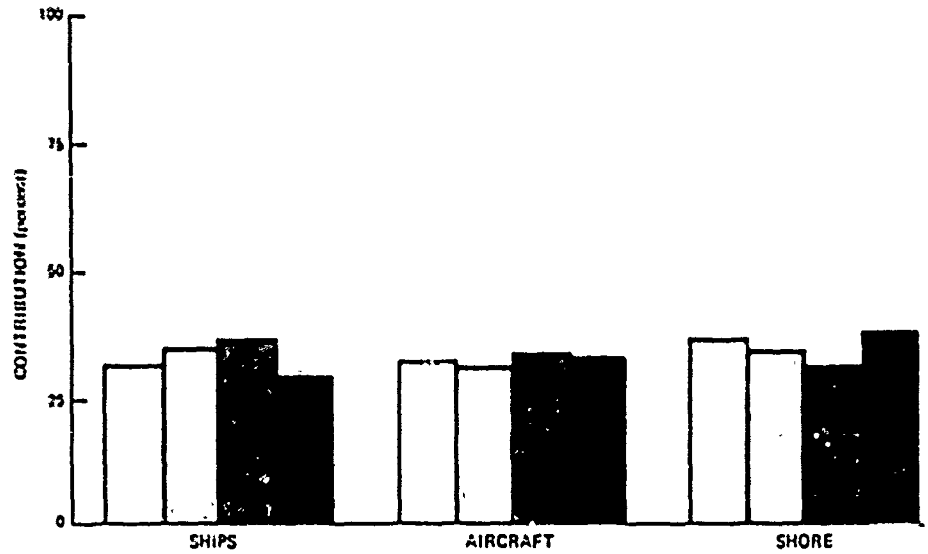
ACTIVITY	FY 73	FY 74	FY 75	FY 76
SHIPS	39.2	34.7	33.7	28.6
AIRCRAFT	25.8	26.1	27.3	28.1
SHORE	35.0	38.6	39.5	43.3

Figure A-2. ENERGY USAGE BY ACTIVITY



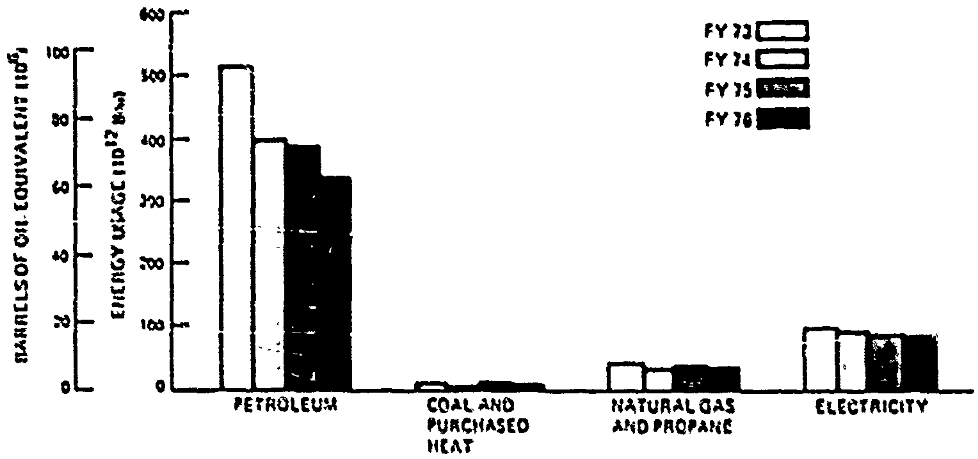
ACTIVITY	ENERGY COST IN DOLLARS (10^6)				CHANGE (percent)		
	FY 73	FY 74	FY 75	FY 76[b]	FY 73-74	FY 73-75	FY 73-76
SHIPS	158.060	263013	414.105	313 994	66.4	162.0	98.7
AIRCRAFT	158 552	238.336	370.433	346.100	50.3	133 6	116.3
SHORE[a]	183.600	260.698	362 836	416 977	46 8	97.0	127.0
TOTAL	500.302	771.047	1147 404	1077 101	54.1	129.2	115.3

[a]INCLUDES UTILITIES AND GROUND SU' 'ORT
[b]PRELIMINARY DATA



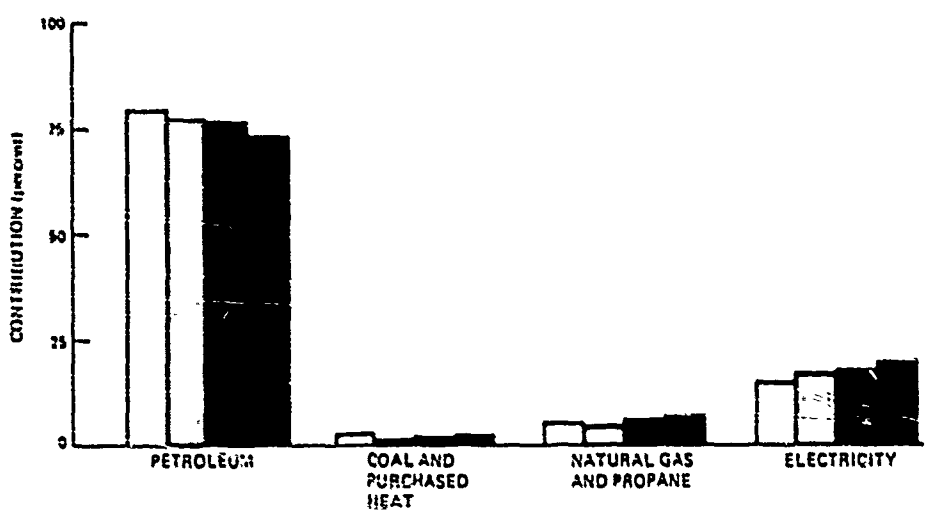
ACTIVITY	CONTRIBUTION (percent)			
	FY 73	FY 74	FY 75	FY 76
SHIPS	31.6	34.1	36.1	29.2
AIRCRAFT	31.7	30.9	32.3	32.1
SHORE	36.7	35 0	31.6	38.7

Figure A-3. ENERGY COST BY ACTIVITY



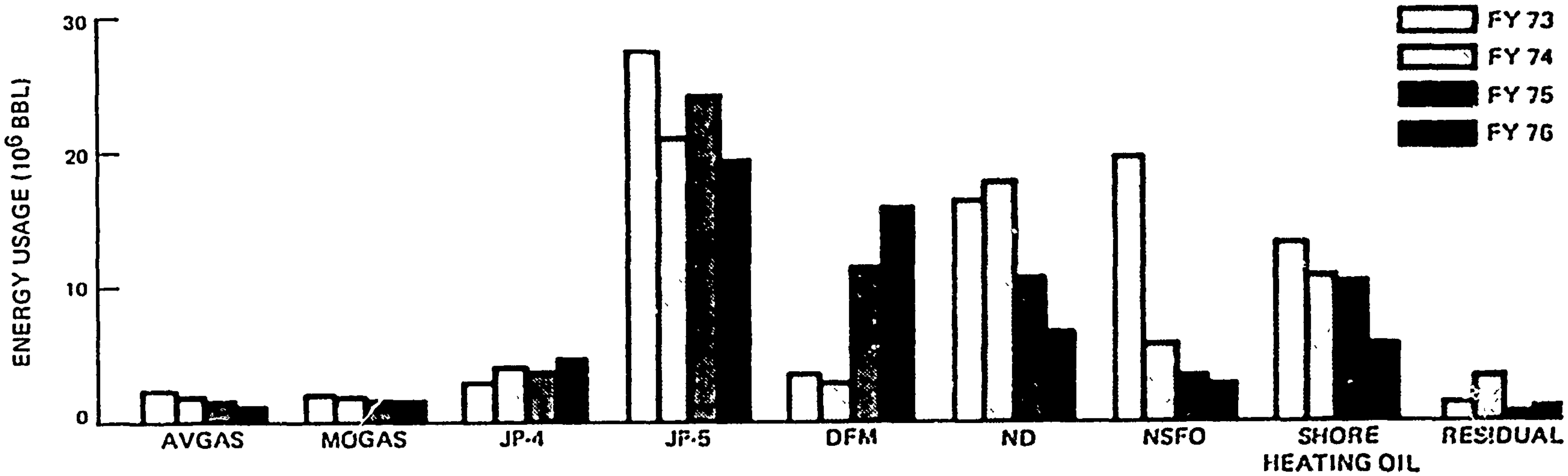
ENERGY FORM	ENERGY USAGE (10^{12} Btu)				CHANGE (percent)		
	FY 73	FY 74	FY 75	FY 76*	FY 73-74	FY 73-75	FY 73-76
PETROLEUM	513.1	398.4	384.6	331.4	-22.4	-25.0	-35.4
COAL AND PURCHASED HEAT	5.8	3.4	4.1	3.9	-41.4	-29.3	-32.8
NATURAL GAS AND PROPANE	35.0	26.5	30.3	30.2	-24.3	-13.4	-13.7
ELECTRICITY	95.8	90.6	89.6	89.5	-5.4	-6.5	-6.6
TOTAL	649.7	518.9	508.6	455.0	-20.1	-21.7	30.0

*PRELIMINARY DATA



ENERGY FORM	CONTRIBUTION (percent)			
	FY 73	FY 74	FY 75	FY 76
PETROLEUM	79.0	76.8	75.6	72.8
COAL AND PURCHASED HEAT	0.9	0.7	0.8	9
NATURAL GAS AND PROPANE	5.4	5.1	6.0	6.6
ELECTRICITY	14.7	17.5	17.6	19.7

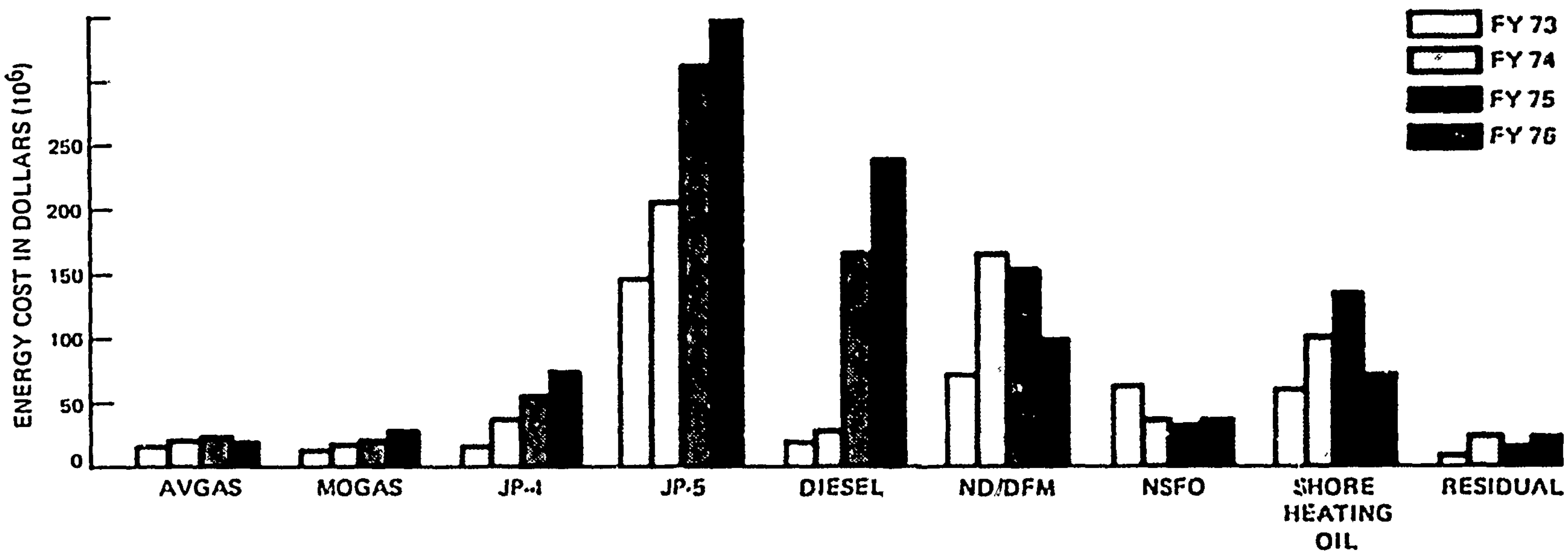
Figure A-4. ENERGY USAGE BY ENERGY FORM



FUEL	PETROLEUM USAGE (10^6 BBL)				CHANGE (percent)			
	FY 73	FY 74	FY 75	FY 76[a]	FY 73-74	FY 74-75	FY 73-75	FY 73-76
AVGAS	2.1	1.6	1.3	.9	−23.8	−18.8	−38.1	−57.1
MOGAS	1.7	1.5	1.3	1.3	−11.8	−13.3	−23.5	−23.5
JP-4	2.5	3.8	3.4	4.3	52.0	−10.5	36.0	72.0
JP-5	27.8	21.6	23.8	19.4	−22.3	10.2	−14.4	−30.2
DFM	3.1	2.6	11.4	15.3	−16.1	338.5	267.7	393.5
ND	16.2	17.8	10.3	6.3	9.9	−42.1	−36.4	−61.1
NSFO	19.3	5.5	2.8	2.4	−71.5	−49.1	−85.5	−87.6
SHORE HEATING OIL	12.9	11.4	10.3	5.1	−11.6	− 9.6	−20.2	−60.5
RESIDUAL	1.7	2.7	0.8	1.4	58.8	−70.4	−52.9	−17.6
UNDEFINED	–	–	1.1	–	–	–	–	–
TOTAL	87.3	68.5	66.5	56.4	−21.5	− 2.9	−23.8	−35.4

[a]PRELIMINARY DATA

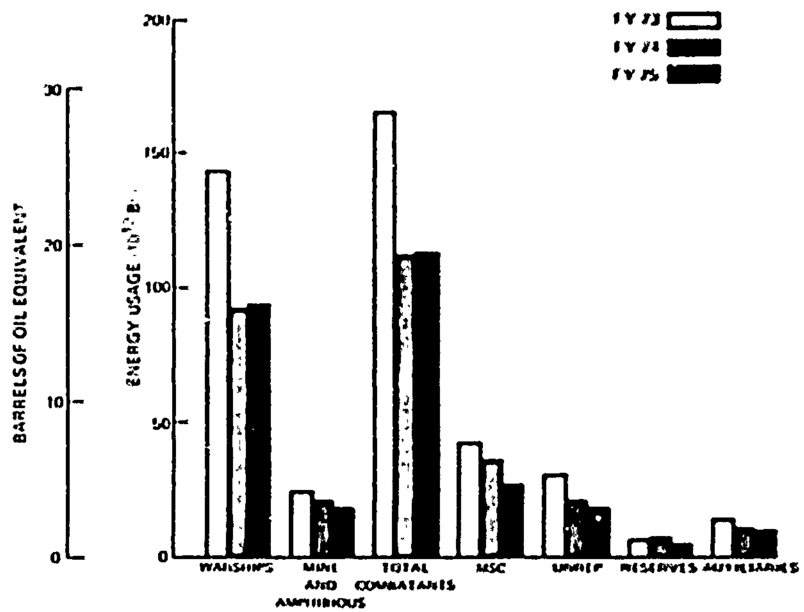
Figure A-5. PETROLEUM USAGE BY FUEL TYPE



FUEL	PETROLEUM COST IN DOLLARS (10^6)			
	FY 73	FY 74	FY 75	FY 76[a]
AVGAS	15.435	19.504	22.603	17.348
MOGAS	10.472	14.280	19.965	22.359
JP-4	12.758	35.365	52.360	71.427
JP-5	143.809	203.225	349.860	310.846
DIESEL	15.190	23.496	163.590	234.228
ND	68.852	162.268	150.991	96.447
NSFO	59.412	42.198	38.524	33.994
SHORE HEATING OIL	57.663	99.180	132.664	68.034
RESIDUAL	5.539	20.715	11.007	19.320
UNDEFINED	-	-	15.833	-
TOTAL	389.160	620.231	957.397	874.003

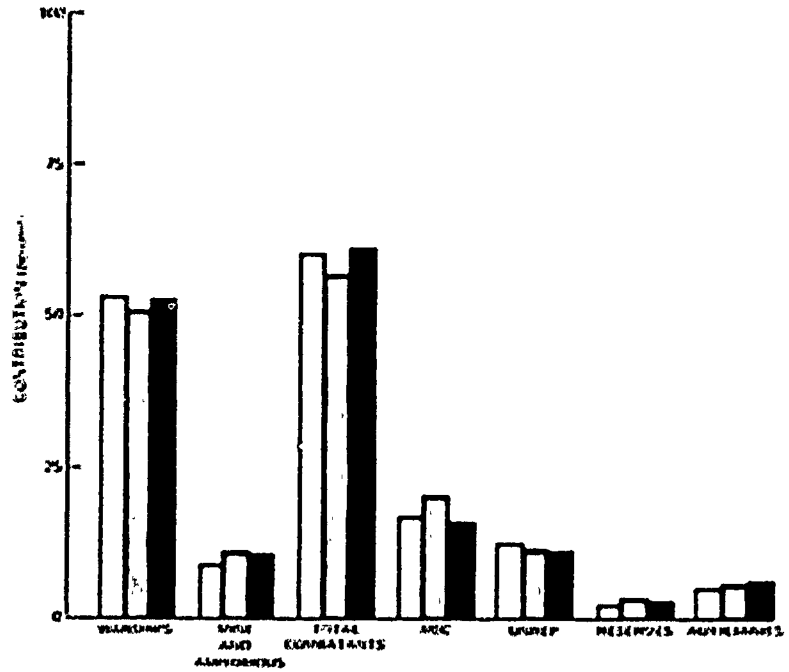
[a]PRELIMINARY DATA

Figure A-6. PETROLEUM COST BY FUEL TYPE



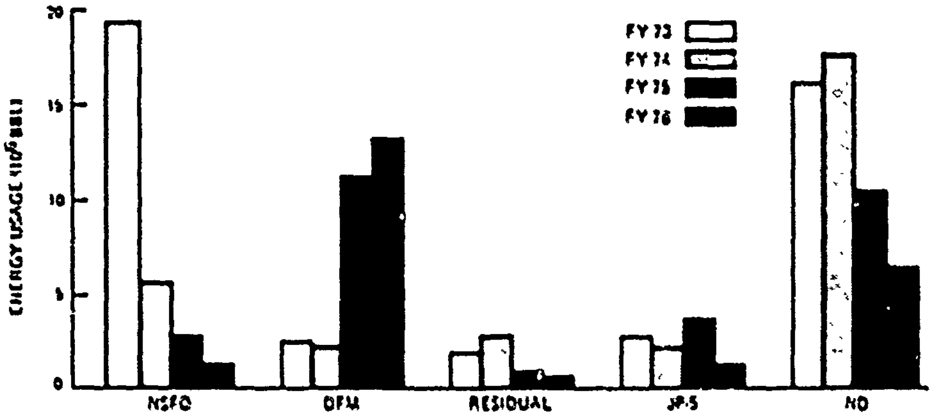
SHIP CLASS	ENERGY USAGE (10^{12} Btu)			CHANGE (percent)	
	FY 73	FY 74	FY 75	FY 73/74	FY 73/75
WARSHIPS	143.1	90.4	93.6	36.8	34.6
MINE AND AMPHIBIOUS	22.4	19.9	18.2	11.1	18.7
TOTAL COMBATANTS	165.4	110.3	111.7	33.2	32.5
MSC*	42.4	34.8	25.6	17.9	39.6
UNREP	29.3	19.4	17.8	33.7	39.2
RESERVES	5.1	5.6	4.6	9.9	9.8
AUXILIARIES	12.3	9.6	9.3	22.6	24.4
TOTAL	254.5	179.7	168.9	29.4	33.6

*INCLUDES ONLY MSC PURCHASES FROM DFSC STOCKS



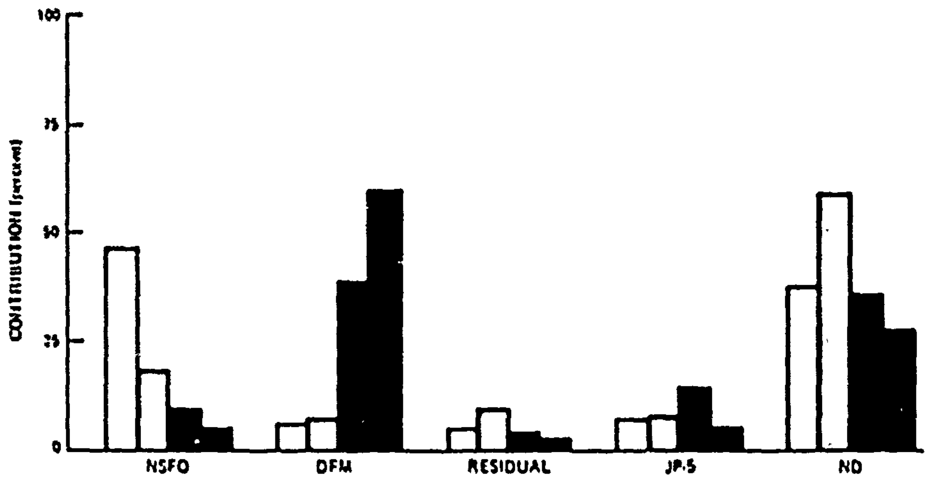
SHIP CLASS	CONTRIBUTION (percent)		
	FY 73	FY 74	FY 75
WARSHIPS	56.2	50.3	55.3
MINE AND AMPHIBIOUS	8.8	11.1	10.8
TOTAL COMBATANTS	65.0	61.4	66.1
MSC	16.7	15.4	15.1
UNREP	11.5	10.8	10.5
RESERVES	2.0	3.1	2.7
AUXILIARIES	4.9	5.3	5.5

Figure A-7. TOTAL ENERGY USAGE BY SHIP CLASS (EXCEPT NUCLEAR)



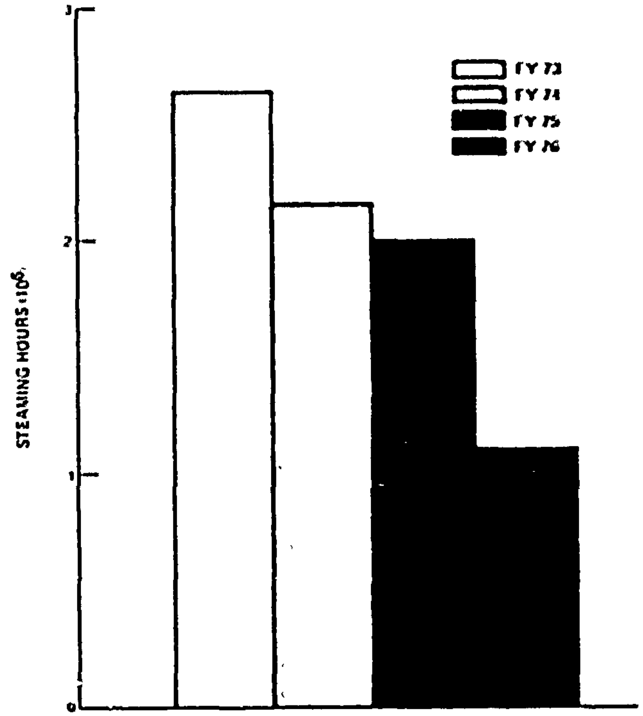
FUEL	PETROLEUM USAGE (10^6 BBL)				CHANGE (percent)		
	FY 73	FY 74	FY 75	FY 76[a]	FY 73-74	FY 73-75	FY 73-76
NSFO	19.3	5.5	2.8	1.1	-71.5	-85.5	-94.3
DFM	2.2	2.0	11.1	13.3	-9.1	404.5	504.5
RESIDUAL	1.7	2.7	0.8	.4	58.8	-52.9	-76.5
JP-5	2.6	2.1	3.7	1.1	-19.2	42.3	-57.7
ND	16.2	17.8	10.3	6.3	9.9	-36.4	-61.1
TOTAL	42.0	30.1	28.7	22.2	-28.3	-31.7	-47.1

[a]PRELIMINARY DATA



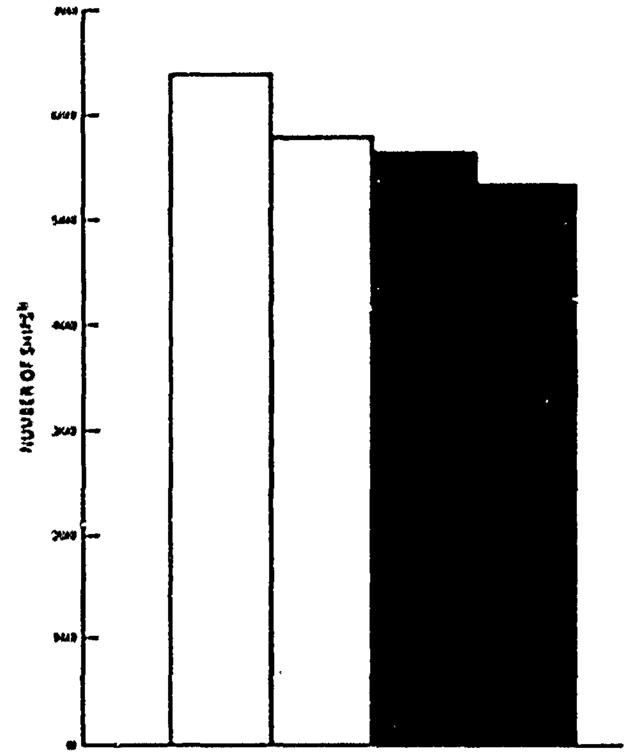
FUEL	CONTRIBUTION (percent)			
	FY 73	FY 74	FY 75	FY 76
NSFO	46.0	18.3	9.8	5.0
DFM	5.2	6.6	38.7	59.9
RESIDUAL	4.0	9.0	2.8	1.8
JP-5	6.2	7.0	12.9	5.0
ND	38.6	59.1	35.9	28.3

Figure A-8. PETROLEUM USAGE FOR SHIPS BY FUEL TYPE



	STEAMING HOURS (10⁶)				CHANGE (percent)		
	FY 73	FY 74	FY 75	FY 76[a]	FY 73-74	FY 73-75	FY 73-76
UNDERWAY	1.618	1.223	1.147	1.031	24.4	29.1	32.6
NOT UNDERWAY	1.007	0.920	0.847	–	8.6	15.9	
TOTAL	2.625	2.143	1.994	–	18.4	24.1	

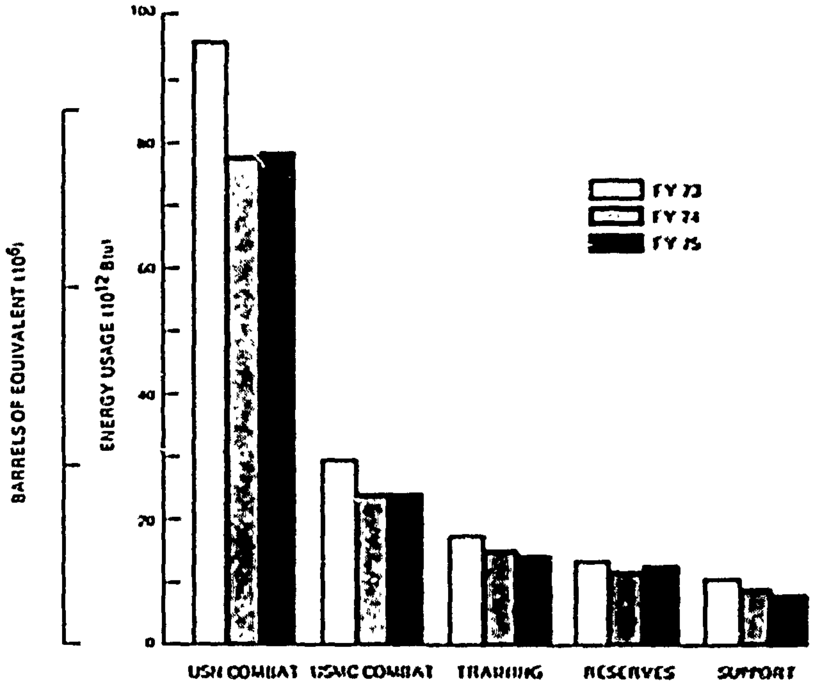
[a]PRELIMINARY DATA



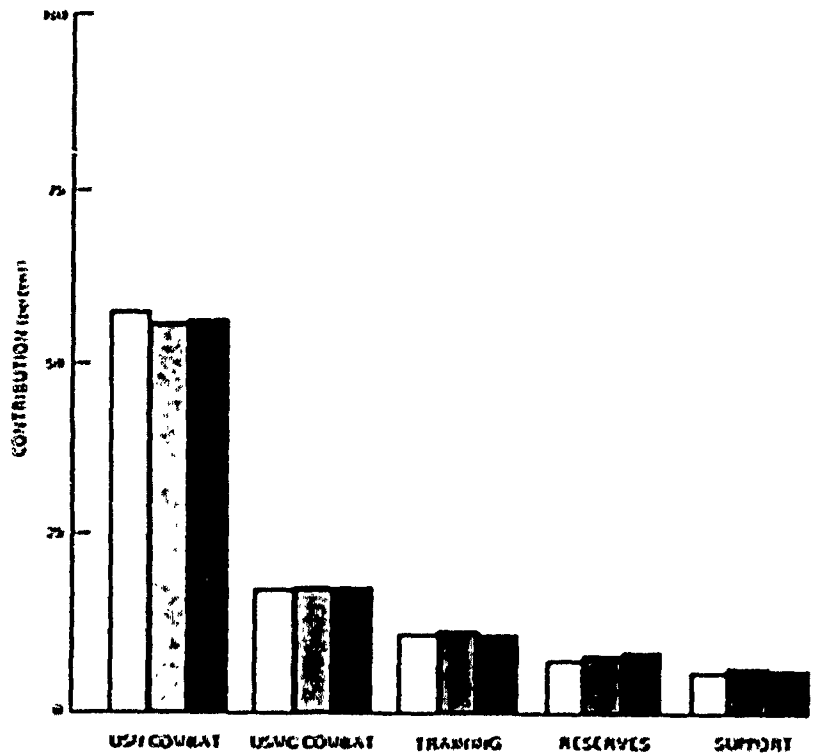
	NUMBER OF SHIPS[b]				CHANGE (percent)		
	FY 73	FY 74	FY 75	FY 76	FY 73-74	FY 73-75	FY 73-76
ACTIVE RESERVE	584 59	512 67	496 63	476 60	12.3 13.6	15.1 6.8	20.5 1.7
TOTAL	643	579	559	536	-10.0	-13.1	-16.6

[b]EXCLUDES MSC

Figure A-9. SHIP ACTIVITY AS MEASURED BY STEAMING HOURS

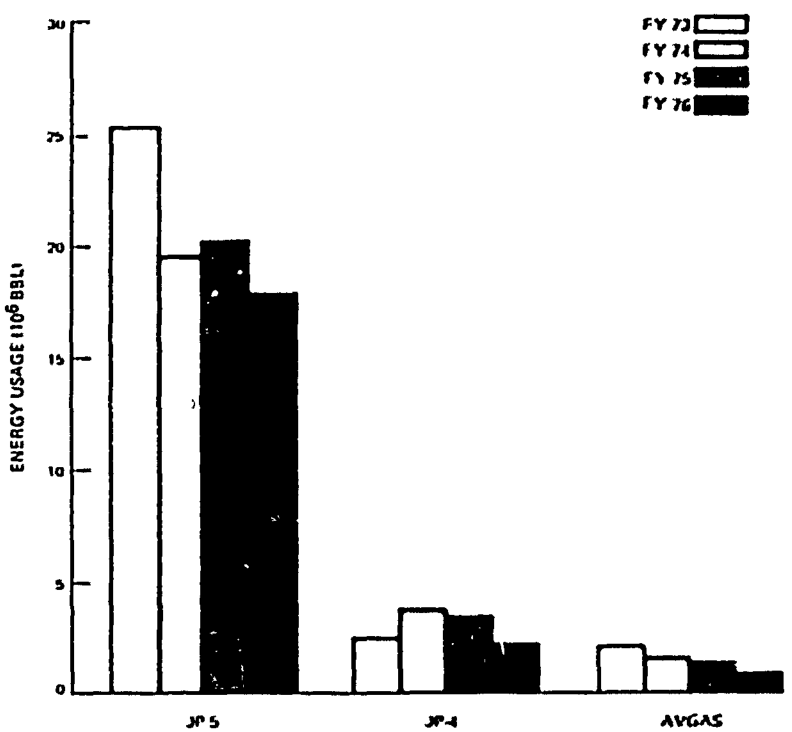


AIRCRAFT	PETROLEUM USAGE (10^{12} Btu)			CHANGE (percent)	
	FY 73	FY 74	FY 75	FY 73-74	FY 73-75
USN COMBAT	96.3	78.0	78.2	19.0	18.9
USMC COMBAT	29.5	24.6	24.6	16.6	16.6
TRAINING	18.1	15.5	14.9	14.4	17.7
RESERVES	13.2	12.0	12.5	9.1	5.3
SUPPORT	10.3	8.9	8.6	-13.6	16.5
TOTAL	167.4	139.0	138.8	17.0	17.1



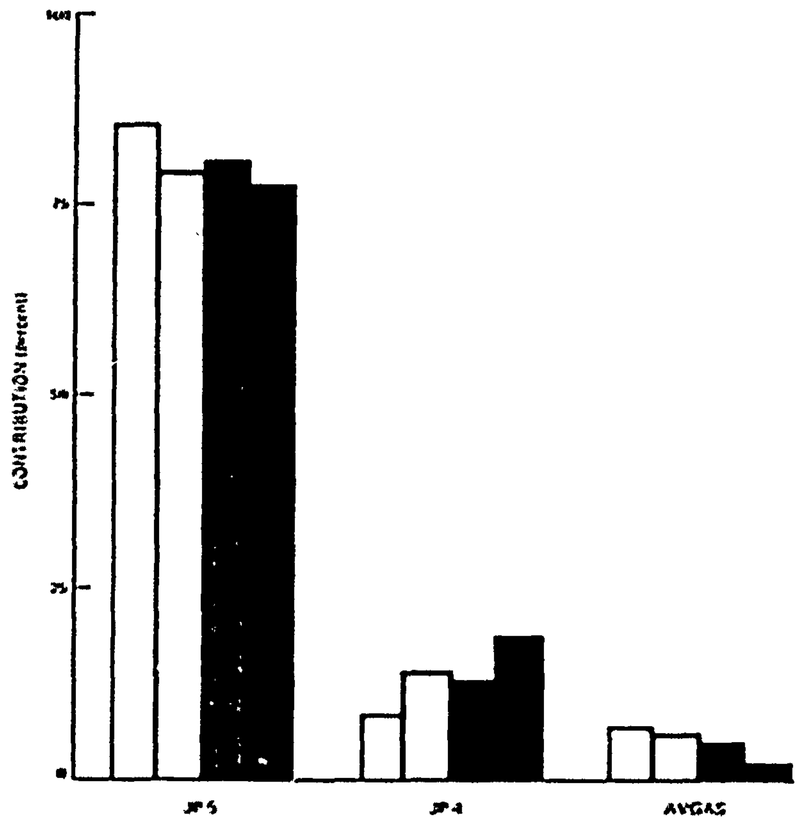
AIRCRAFT	CONTRIBUTION (percent)		
	FY 73	FY 74	FY 75
USN COMBAT	57.5	56.1	56.4
USMC COMBAT	17.6	17.7	17.7
TRAINING	10.8	11.1	10.7
RESERVES	7.9	8.7	9.0
SUPPORT	6.1	6.4	6.2

Figure A-10. PETROLEUM USAGE BY AIRCRAFT



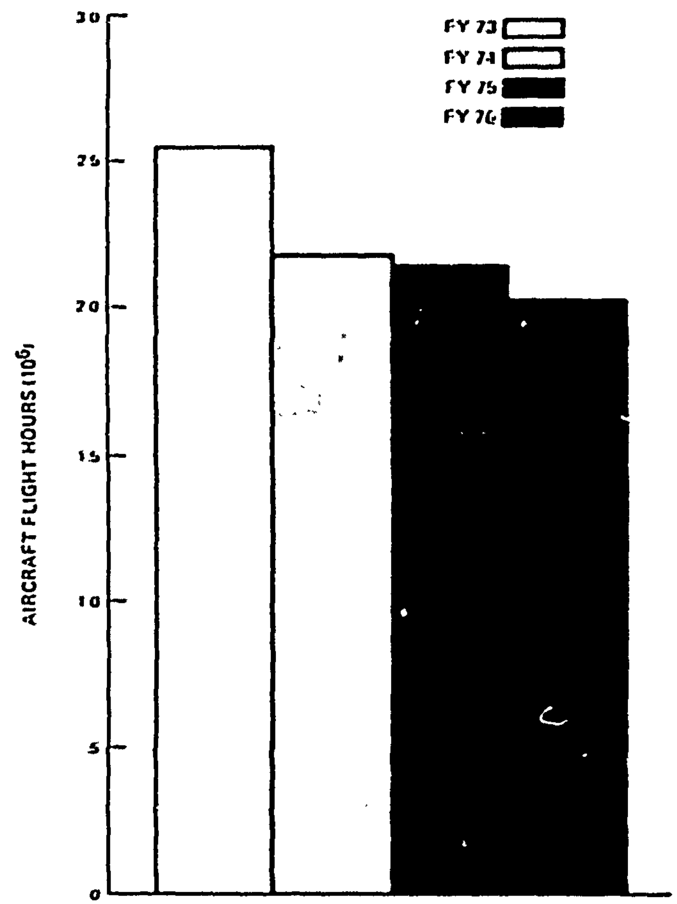
FUEL	PETROLEUM USAGE (10^6 BBL)				CHANGE (percent)		
	FY 73	FY 74	FY 75	FY 76[a]	FY 73 74	FY 73 75	FY 73 76
JP-5	25.2	19.5	20.1	17.7	22.6	20.2	29.8
JP 4	2.5	3.8	3.4	4.3	52.0	36.0	72.0
AVGAS	2.1	1.6	1.3	.9	23.8	38.1	47.9
TOTAL	29.8	24.9	24.8	22.9	16.4	16.8	23.2

[a]PRELIMINARY DATA



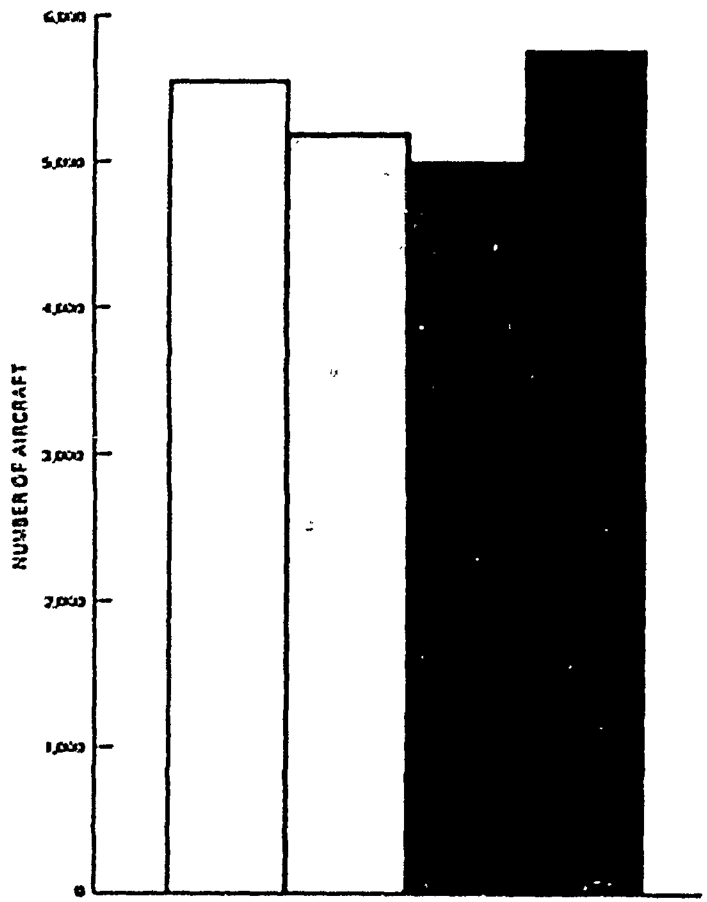
FUEL	CONTRIBUTION (percent)			
	FY 73	FY 74	FY 75	FY 76
JP-5	86.4	79.6	82.1	77.3
JP-4	8.0	14.5	13.1	18.8
AVGAS	6.6	5.9	4.8	3.9

Figure A-11. PETROLEUM USAGE FOR AIRCRAFT BY TYPE



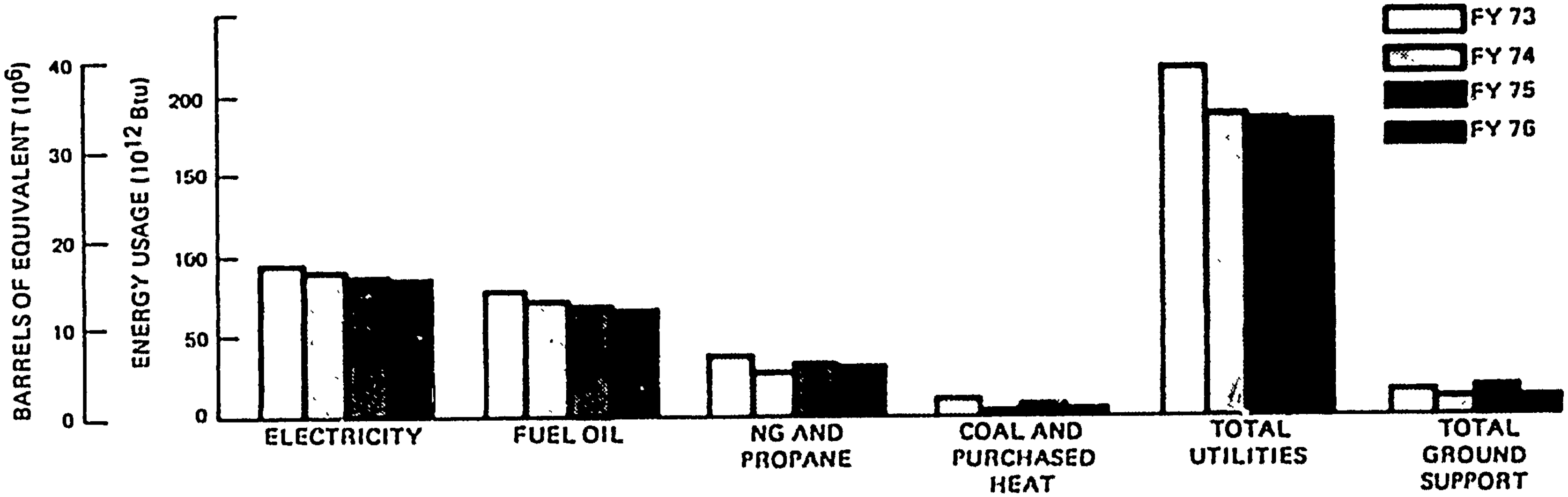
FLIGHT HOURS (10^6)				CHANGE (percent)		
FY 73	FY 74	FY 75	FY 76*	FY 73 74	FY 73 75	FY 73 76
2.551	2.187	2.144	2.010	14.3	15.9	21.2

*PRELIMINARY DATA



NUMBER OF AIRCRAFT				CHANGE (percent)		
FY 73	FY 74	FY 75	FY 76	FY 73 74	FY 73 75	FY 73 76
5,590	5,179	4,915	5,752	7.4	12.1	2.9

Figure A-12. AIRCRAFT ACTIVITY AS MEASURED BY FLIGHT HOURS



ENERGY FORM	ENERGY USAGE (10^{12} Btu)				CHANGE (percent)		
	FY 73	FY 74	FY 75	FY 76[a]	FY 73-74	FY 73-75	FY 73-76
ELECTRICITY	95.8	90.6	89.6	89.5	− 5.4	− 6.5	− 6.6
FUEL OIL	77.2	68.1	61.8	61.7	−11.8	−19.9	−20.1
NATURAL GAS AND PROPANE	34.8	26.5	30.3	30.2	−23.9	−12.9	−13.2
COAL AND PURCHASED HEAT	5.8	3.4	4.1	3.9	−41.4	−29.3	−32.7
TOTAL UTILITIES	213.6	188.6	185.8	185.3	−11.7	−13.0	−13.2
TOTAL GROUND SUPPORT	14.1	11.5	15.1	11.7	−18.4	− 7.1	−17.0
TOTAL	227.7	200.1	200.9	197.0	−12.1	−11.8	−13.5

[a]PRELIMINARY DATA

Figure A-13. SHORE ENERGY USAGE BY ENERGY FORM

APPENDIX B

PROJECTED NAVY ENERGY REQUIREMENTS 1977-2000

APPENDIX B

PROJECTED NAVY ENERGY REQUIREMENTS 1977-2000

The designated program manager for the Navy Energy Usage Profile and Analysis System (NEUPAS) is the Navy Energy and Natural Resources R&D Office (MAT-03Z). MAT-03Z is assisted by the Navy Facilities Engineering Command Energy and Utilities Division (FAC-102) and the David W. Taylor Naval Ship Research and Development Center (DTNSRDC). The mission resource and program sponsor is the Deputy Chief of Naval Operations for Logistics, OP-04.

NEUPAS was designed to provide the historical patterns of energy usage discussed in Appendix A. In addition, NEUPAS uses the historical energy usage data to predict general and specific future Navy energy requirements. This system, outlined in Figure B-1, is a compilation of the end-user fuel and utility energy consumption reports, operational hours reports, and current force-level data that had been manually gathered for previous studies. The data are supplemented with projected force levels, unit energy usage characteristics, and energy cost information to support the predictive analysis. The function of the three analyses and the data resources used by each are described below.

The Historical Energy Usage Profile Analysis Program uses the data shown in Figure B-1 to produce yearly (as currently structured) energy usage profiles, interyear comparisons, and historical energy usage trends. The analysis output includes energy usage, which is sorted by energy source down to the level of individual ship hull and airframe numbers and individual shore stations, tabulated up through ship and aircraft classes and major claimants, as well as activity-level data (steaming and flying hours) for ships and aircraft. Historical energy cost is presently a calculated value for ships and aircraft, obtained by multiplication of the yearly average Navy Petroleum Office fuel price by consumption for the year, and is an actual reported expenditure for shore energy, which is obtained from NAVFAC. The basic ship data elements manipulated by this program (Figure B-2) include the Fuel Consumption and Steaming Hours reports submitted by each active fleet and reserve force ship to its fleet command. Fuel consumption data for the Military Sealift Command (MSC) nucleus fleet ships are taken from the Defense Energy Information System (DEIS-I) report and tabulated manually for only those chartered MSC ships that are fueled by government fuel stocks. Aircraft data include the total flying hours of each Navy and Marine Corps aircraft as reported to the Naval Aircraft Inventory Management System (NAIMS) and the aircraft fuel consumption rates from the Flying Hours Program Management System (FHPMS), maintained by OP-511, used to produce aircraft fuel consumption data. Shore facility energy usage data is taken from the DEIS-II reporting system. The current ship force levels, obtained from the Ship Systems Management Information System (OP-902G2) is used to cross-check the completeness of the ship fuel consumption report submissions. In addition, liquid energy source data taken from the

DEIS-I is used both as a further differentiation by fuel type for shore utilities, administrative, and ground combat support functions and as a cross-check for fuel consumption by ships, aircraft, and shore elements. The program has been written to allow error identification in both of these cases. In addition, the program provides permanent data files of all data sources, as well as historical output files, to provide a base for such specialized historical studies as might be required and for input to the projection programs.

The FY 2000 Energy Usage Projection Program (Figure B-3) forecasts total Navy energy usage and cost yearly through FY 2000, based on projected force levels, energy cost, and unit consumption. The projection output is broken down for ships and aircraft by year, ship class or aircraft type, and fuel type. The program uses the historical energy usage data and operational hours data to establish average fuel consumption rates for each existing ship class and aircraft type. Projected ship force levels are those taken from sources listed in Figure B-2, including the current Five-Year Defense Plan (FYDP), the Program Objectives Memorandum (POM) and the Extended Planning Annex (EPA). Projected aircraft force levels are taken from the Aircraft Material Program (NAVAIR-1014) and the Single Plan by Model (OP-508). Since no aircraft data are generally available for the period beyond FY 1995, these sources have been manually extended through FY 2000 in a continuation of indicated aircraft replacement trends. MSC energy utilization projections are now based on a historical percentage of that of the ship community for liquid fuels. Projected unit energy usage characteristics for new ships and aircraft are based upon the characteristics of those units that are replaced, using properly scaled fuel consumption figures. In the case of new types of ships and aircraft, projected fuel consumption is based either upon projections available from appropriate NAVSEA/NAVAIR program managers or upon empirical relationships between appropriate displacement/speed/shaft horsepower characteristics and fuel rates. Shore energy usage projections for this appendix were not produced by NEUPAS, although that capability exists. NAVFAC (FAC-102) gave their best assessment of Navy shore energy requirements through the year 2000. Figure B-4 and Table B-1 give the Navy Best Assessment of energy usage through FY 2000.

The Scenario Energy Usage Projection Program (Figure B-5) is essentially a special case of the FY 2000 projection. The program projects the energy needs of specifically defined task force size naval units, based on appropriate sections of the total FY 2000 projection. Parameters at the option of the analyst are task force units (both ship and aircraft types and numbers), the operating tempo, and the operational duration. Shore-energy usage specific unit projections are presently omitted because the projected figures supplied by NAVFAC were too optimistic, assuming all energy and engineering programs received full funding.

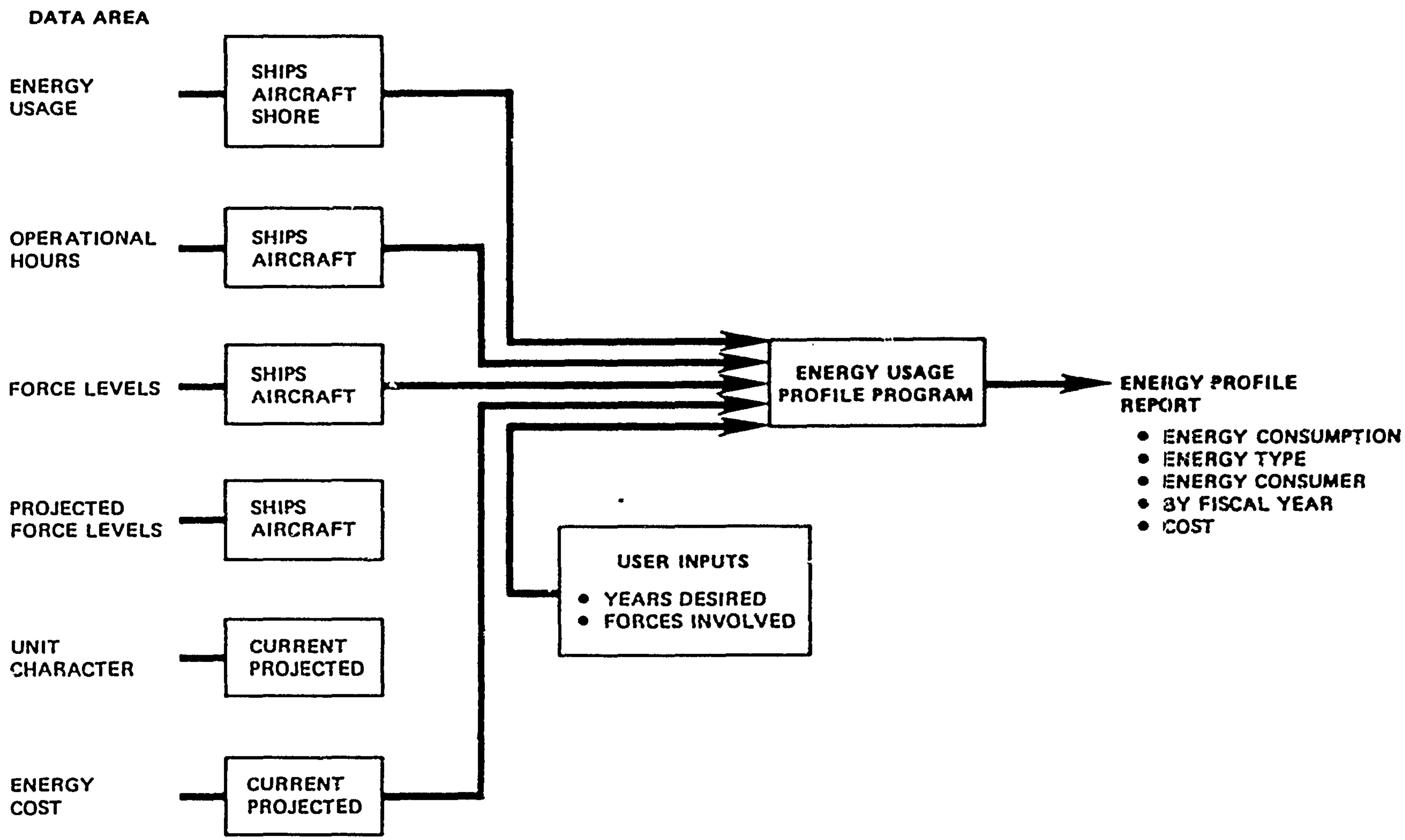


Figure B-1. HISTORICAL ENERGY USAGE PROFILE PROGRAM

DATA AREA		DATA SOURCES
ENERGY USAGE	SHIPS:	FUEL/STEAMING HOURS REPORT (CINCLANT/PAC, MSC); DEIS I
	AIRCRAFT:	FLYING HOURS PROGRAM MANAGEMENT SYSTEM (OP 511); DEIS I
	SHORE:	DEIS II (NAVFAC)
OPERATIONAL HOURS	SHIPS:	FUEL/STEAMING HOURS REPORT (CINCLANT/PAC)
	AIRCRAFT:	NAVAL AIRCRAFT INVENTORY MANAGEMENT SYSTEM (NAIMS)
FORCE LEVELS	SHIPS:	SHIP MANAGEMENT INFORMATION SYSTEM (OP 902G2)
	AIRCRAFT:	NAVAL AIRCRAFT INVENTORY MANAGEMENT SYSTEM (NAIMS) (OP 511)
PROJECTED FORCE LEVELS	SHIPS:	EPA/POM (OP 902)
	AIRCRAFT:	AIRCRAFT MATERIAL PROGRAM (NAVAIR 1014) SINGLE PLAN BY MODEL (OP 508)
UNIT CHARACTER	CURRENT:	NAVMAT P-4000
	PROJECTED:	PLANNING DIVISIONS: NAVAIR, NAVSEA, CNO
ENERGY COST	CURRENT:	NPO/OP 413
	PROJECTED:	VARIOUS MODELS (ANALYST SPECIFIED)

Figure B-2. DATA SOURCES

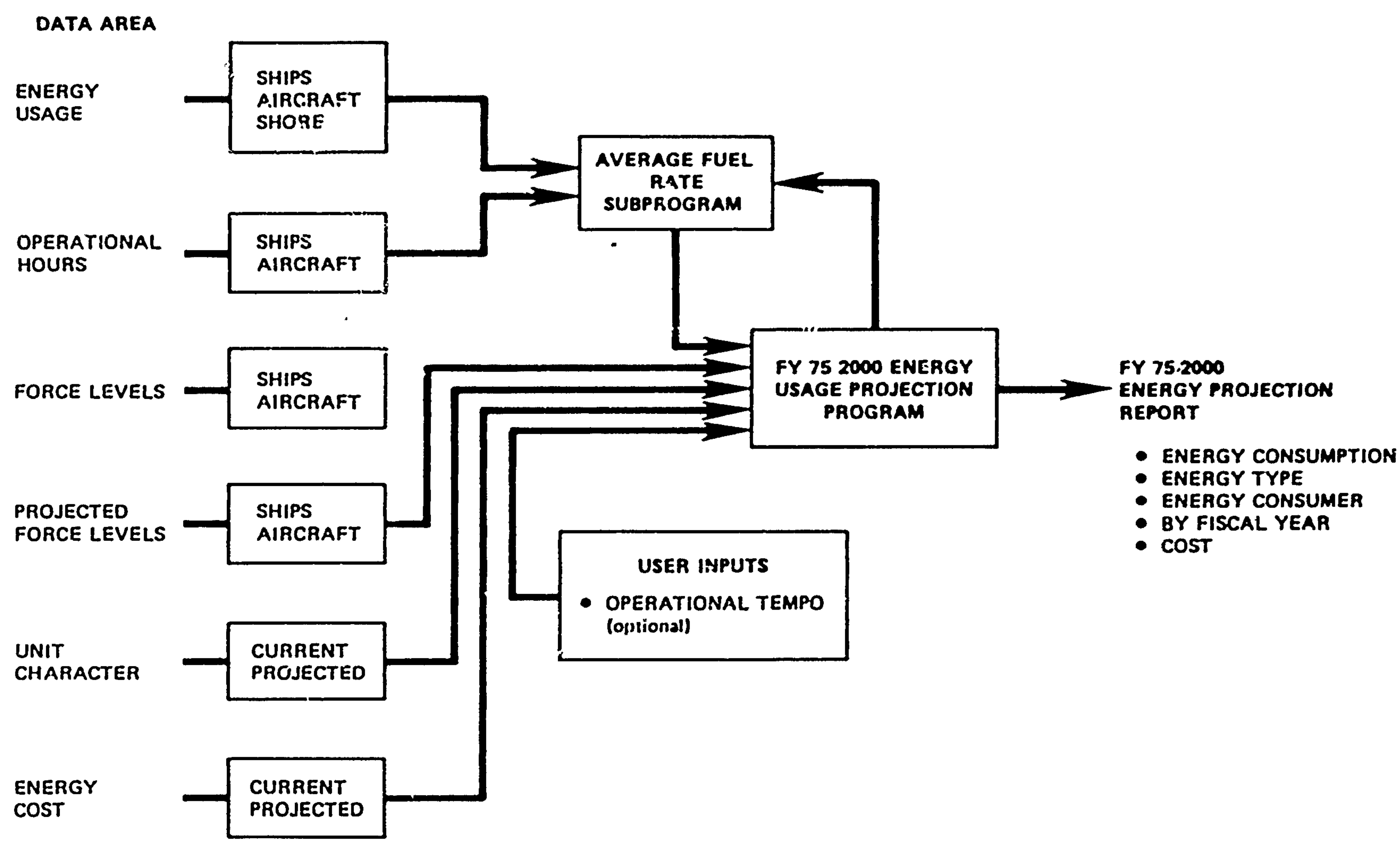


Figure B-3. FY 2000 ENERGY USAGE PROJECTION PROGRAM

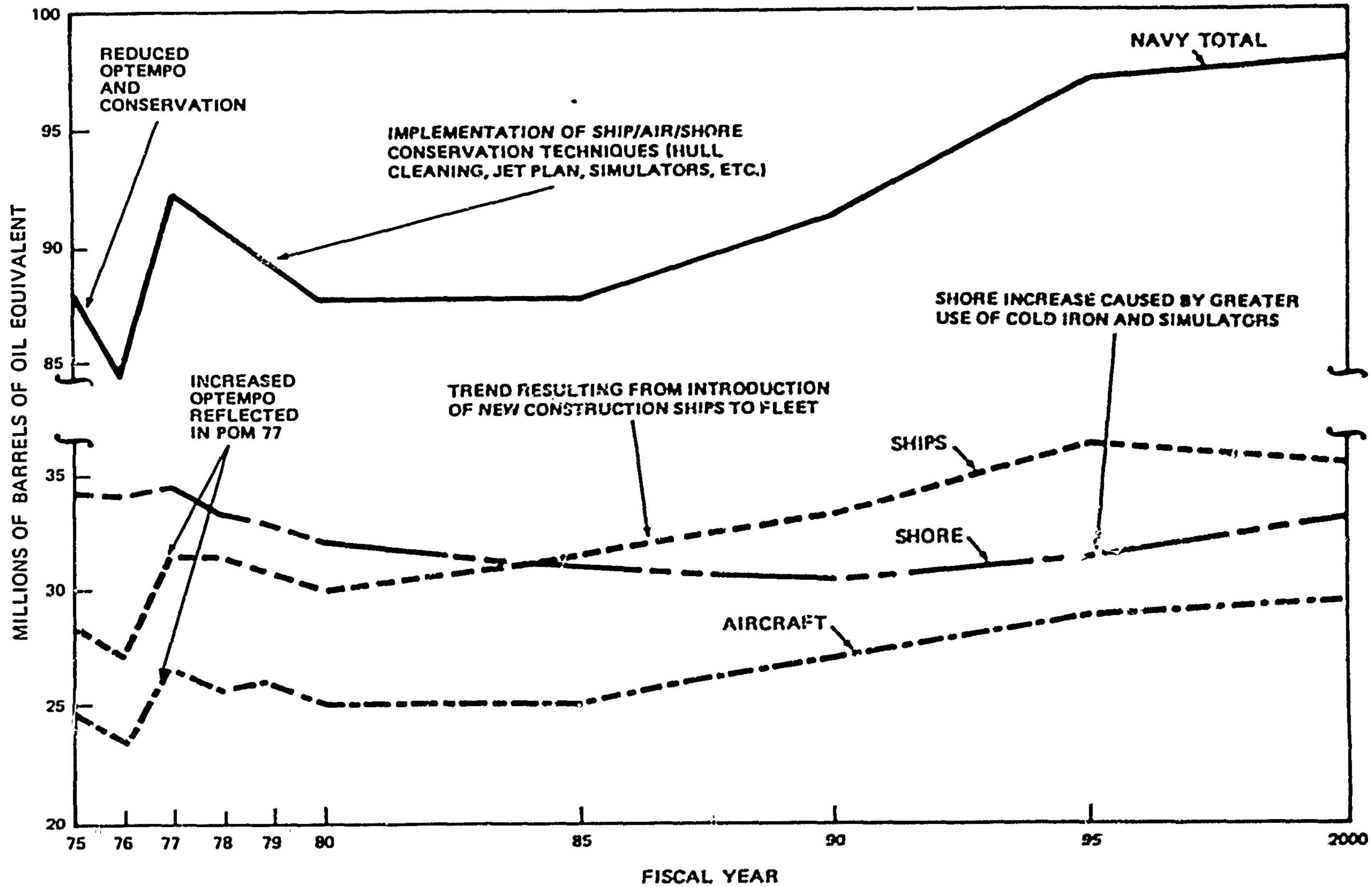


Figure B-4. NAVY ENERGY REQUIREMENTS TO 2000

Table B-1. NAVY BEST ASSESSMENT ENERGY PROJECTIONS TO FY 2000 (MILLIONS OF BARRELS)

	FY 1976	FY 1977	FY 1978	FY 1979	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000	Total FY 1976-2000
Petroleum fuels	62.5	70.5	69.9	69.0	67.4	67.7	70.9	75.1	73.8	1751.3
Fleet	22.5	26.6	26.6	25.9	25.5	26.7	28.3	30.8	30.0	688.1
MSC	4.3	4.8	4.8	4.6	4.5	4.8	5.0	5.5	5.4	122.9
Aircraft	23.4	26.3	25.8	26.0	25.1	25.1	27.1	29.2	29.5	663.5
Shore heating oil	10.0	10.1	9.9	9.6	9.5	8.2	7.5	6.3	5.6	202.7
Ground support	2.3	2.8	2.8	2.9	2.8	2.9	3.0	3.3	3.3	74.1
Natural gas (MBOE)	5.0	4.7	4.5	4.1	3.9	2.6	2.2	2.0	1.8	73.6
Coal (MBOE)	0.4	0.4	0.4	0.6	0.9	2.5	3.1	3.3	3.5	54.3
Propane, purchased heat, other (MBOE)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	1.2	2.4	14.1
Purchased electricity (MBOE)	16.3	16.4	15.8	15.3	14.9	14.3	14.5	15.3	16.4	375.2
Navy total	84.5	92.4	90.9	89.3	87.4	87.4	91.0	96.9	97.9	2268.5

MBOE Millions of barrel oil equivalent.

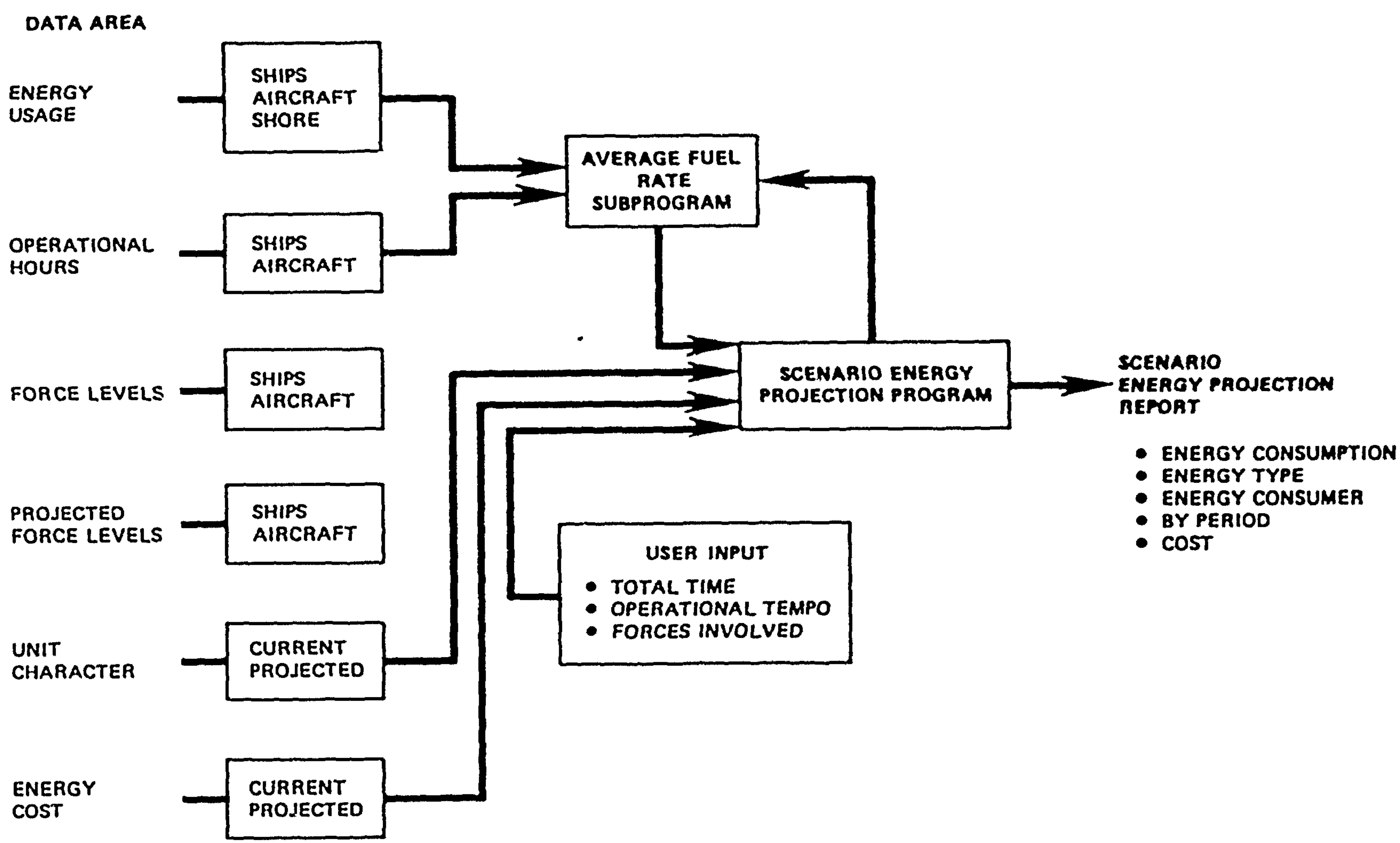


Figure B-5. SCENARIO ENERGY USAGE PROJECTIONS PROGRAM

APPENDIX C

APPLICATION OF ENERGY MODELS TO NAVY ENERGY COST PROJECTION ANALYSIS

APPENDIX C

APPLICATION OF ENERGY MODELS TO NAVY ENERGY COST PROJECTION ANALYSIS

INTRODUCTION

Navy fuel[1] requirements are fulfilled by the Defense Fuels Supply Center (DFSC) through vendor contracts, which it administers. DFSC buys from the vendor that offers the lowest laid-down cost (the total cost of the product FOB the refinery plus transportation cost to the using activity). Under DFSC's integrated fuels management authority, the cost of supplying fuel to all the military services anywhere in the world is recovered by charging a standard price for each major fuel when it is transferred from DFSC's wholesale system to the consumer. The standard price remains fixed, regardless of the service user's geographic location. Four DFSC standard fuel prices for recent years are plotted in Figures C-1 through C-4. The figures also show the average procurement contract prices for fuels that were bought by DFSC during FY 1973-75. The data were taken from DFSC's *Summary of Procurement Statistics.* DFSC standard price analyses are prepared quarterly; however, the prices are adjusted as required to cover DFSC's product cost, transportation cost, and fuel storage cost. The product procurement contract prices reported by DFSC reflect prices in effect on the date of contract award; the data were not adjusted for price increases, although such provisions are included in the contracts. Therefore, the average prices shown may be lower than the prices the government actually paid the vendor.

Not all Navy fuel is purchased at DFSC standard prices. According to Navy Petroleum Office (NAVPETOFF) records, during the third quarter of FY 1975, 70 percent of all Navy fuel was purchased from DFSC or the other military services at DFSC standard prices. During the same time, 30 percent of the fuel was purchased locally or by DFSC-negotiated contracts for direct delivery to the military services. The unit prices paid for fuels under these contracts are negotiated in the open market and may be higher or lower than the DFSC standard price at the time of purchase. NAVPETOFF estimates, however, that the prices average out somewhat lower than but close to the standard price. Therefore, it is assumed that nearly all Navy petroleum fuels are purchased at or near DFSC standard prices.

[1] Throughout this appendix, "Navy fuels" refers to coal and petroleum fuels. The term does not include nuclear fuels. Purchased steam makes up only a small fraction of Navy shore energy usage, and a large portion of it is provided by the Army or Air Force as the host service on bases where Navy activities are tenants. Purchased natural gas and electricity for Navy shore use is generally obtained from local utility companies under contracts negotiated by the cognizant NAVFAC Engineering Field Divisions.

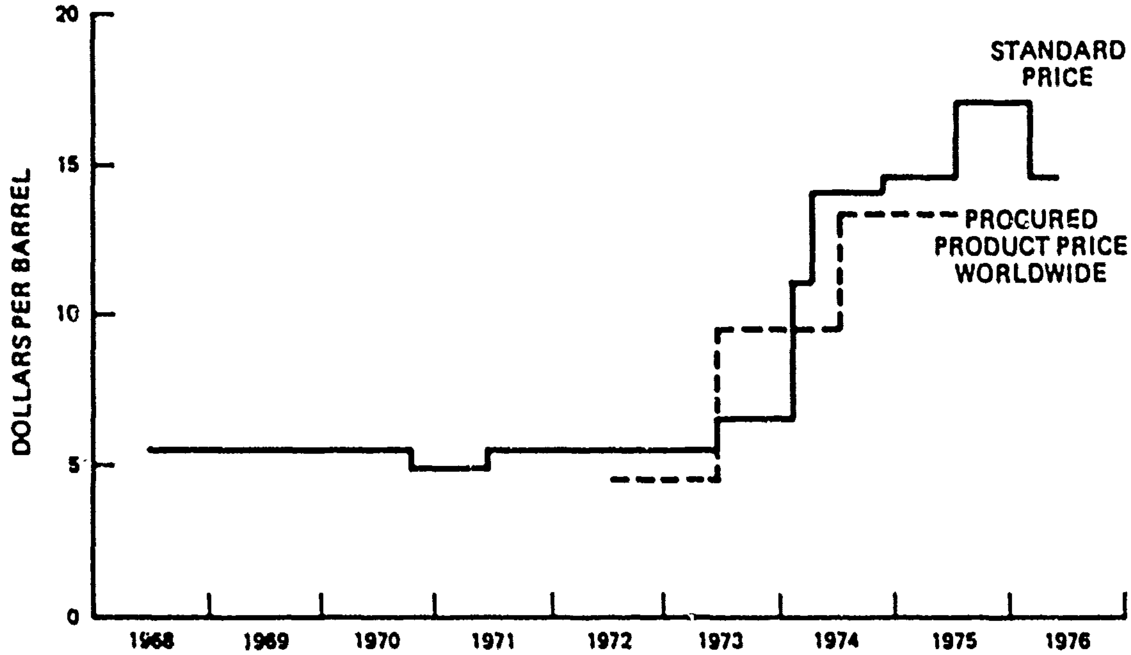


Figure C-1. HISTORICAL DFSC PRICE TRENDS FOR JP-5

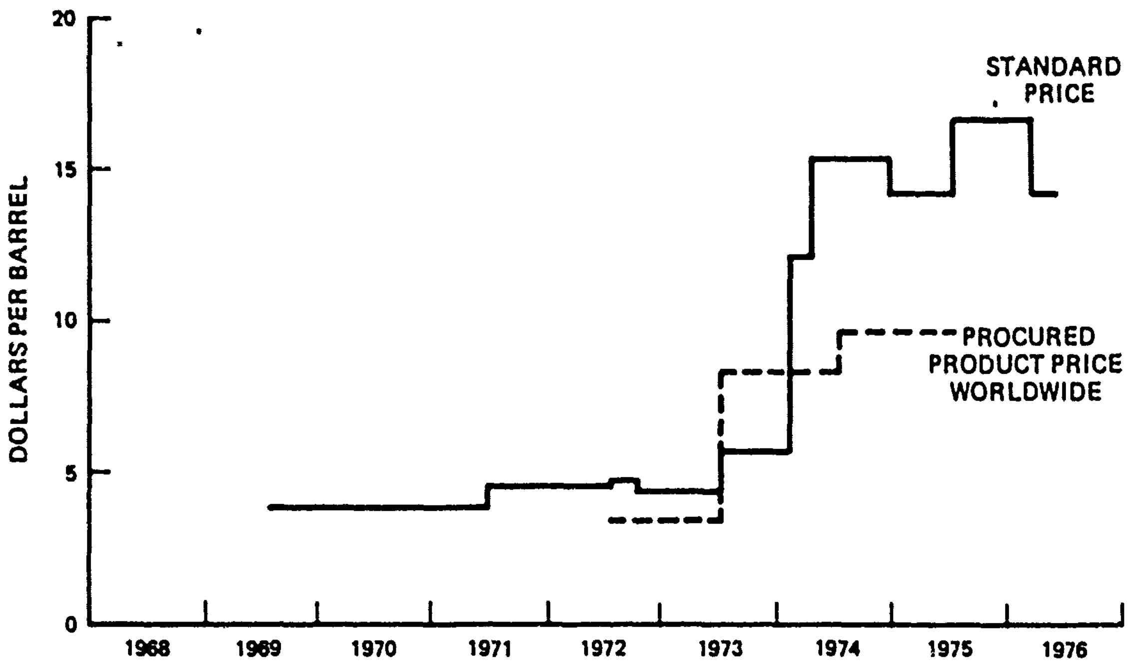


Figure C-2. HISTORICAL DFSC PRICE TRENDS FOR ND

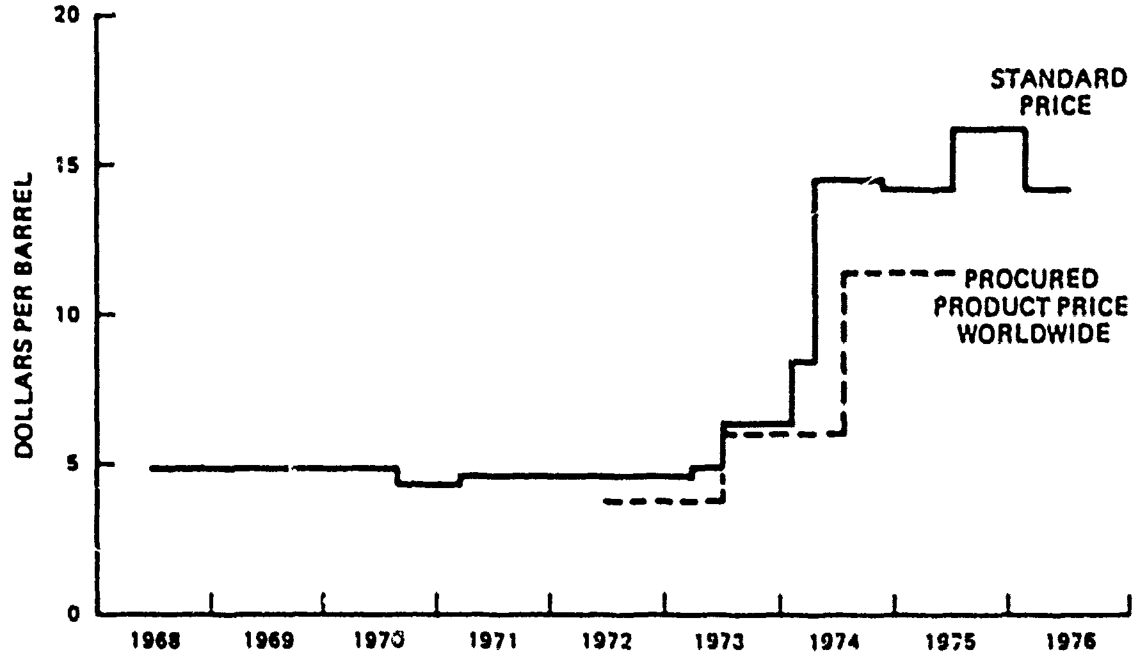


Figure C-3. HISTORICAL DFSC PRICE TRENDS FOR DFM

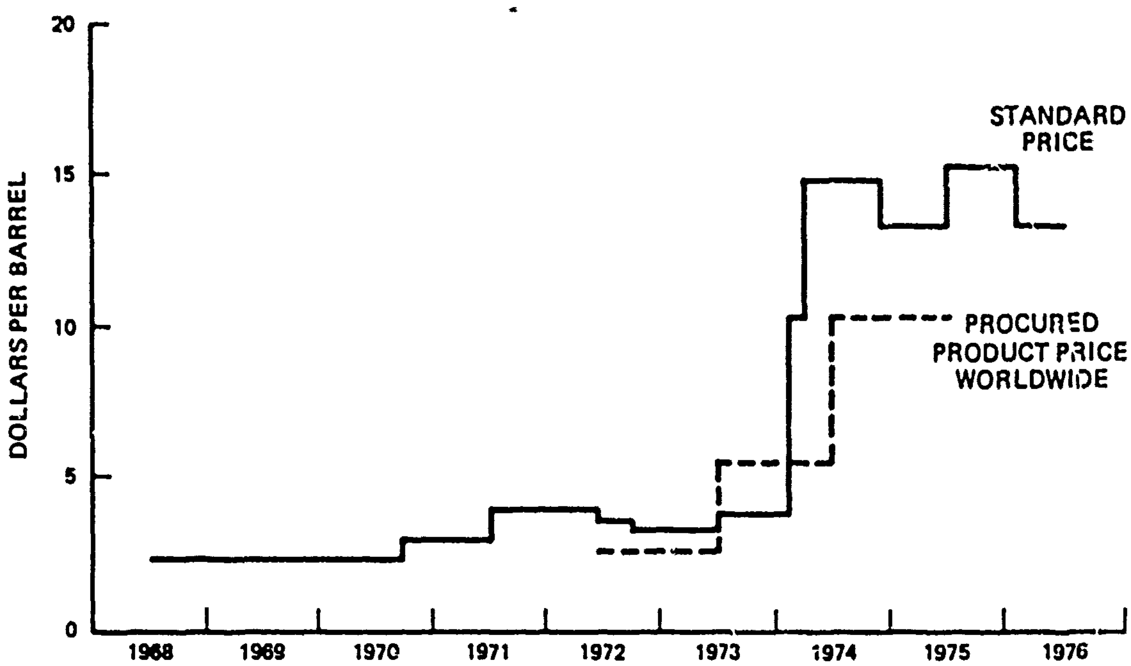


Figure C-4. HISTORICAL DFSC PRICE TRENDS FOR NSFO

FUTURE WORLD, U.S., AND NAVY ENERGY ALTERNATIVES

National policies must be directed toward limiting the nation's dependence on foreign energy sources by developing and implementing techniques for

- Using energy sources other than petroleum for all applications that do not require portable (liquid) fuels;
- Recovering petroleum more completely from the nation's petroleum reserves;
- Converting nonportable fuels into usable liquid fuels;
- Conserving all forms of energy.

Political, economic, technical, and time constraints suggest that the best federal effort that can be expected is subsidizing energy development and implementation efforts. This must be done so that the ratio of fuel imports to total U.S. consumption can be maintained at about the current level.

Based on the experience of the past few years, it is possible that the Petroleum-Oil-Lubricants (POL) budget will be the controlling factor affecting future peacetime fleet, aircraft, and shore operations; it will dictate to a large extent the readiness of fleet units. Therefore, the Navy must give close attention to projected future energy prices. Several different processes are now being used to make energy cost projections. To show a range of possible future U.S. energy prices and import ratios, five cases were developed using different projection processes and assumptions regarding U.S. energy supplies and import energy prices. Navy energy prices were calculated from assumed U.S. energy prices and the assumed world (import) energy prices. These prices were multiplied by projected Navy energy consumption requirements to project annual Navy energy expenditures. A description of this analysis follows.

PROJECTED U.S. ENERGY PRICES AND IMPORT RATIOS

Projecting future Navy energy prices and expenditures involved determining U.S. energy prices for five different cases, each of which assumed varying amounts of U.S. energy supplies and cost of imported fuels. Navy energy prices were calculated and multiplied by projected Navy energy consumption quantities to project annual Navy energy expenditures. U.S. energy import ratios were varied for three of the five cases.

Two basic approaches are in general use for projecting energy prices. One, based on best judgment, involves making qualitative and quantitative assessments of various energy-related factors and the effect on energy costs and then estimating energy prices. The other involves developing a mathematical model to represent the interactions among the various relevant factors. The model may be simple or complex, static or dynamic, and use any of several techniques to represent the interactions among the various elements in the energy system to be analyzed.

The judgmental approach is obviously easier to implement and can more readily accommodate such unquantifiable factors as future U.S. or world political climates. The mathematical modeling approach is more difficult and expensive to implement, but it can more readily consider complex interactions among many quantifiable factors and indicate the sensitivity of the outcomes to variations in those factors. (The simpler models are less capable of handling complex dynamic interactions among factors; but they are more capable of handling arbitrarily variable inputs than are more complex models.) The techniques used for the five cases analyzed in this study ranged from a simple judgmental process to a complex dynamic network model.

Although U.S. energy models do not directly project prices the Navy will pay for energy procured overseas, they can be used to determine energy prices for fuel the Navy will procure from the U.S. civilian energy market. Based on a brief survey of available U.S. energy models, two were selected to project civilian prices: Stanford Research Institute's (SRI) U.S. Energy Model and Federal Energy Administration's (FEA) Short-Term Petroleum Forecasting Model (STPF). These two models predict the future U.S. energy situation (domestic, imported, and synthetic energy quantities and prices, and other input quantities) for the long term (SRI) and the short term (FEA) under given conditions: amount of U.S. reserves; U.S. production/price controls and incentives; and import price controls. In addition to these two models, two differing judgmental techniques were used in the study.

The SRI model was used to test the stability of energy product prices and import ratios, assuming reasonable variations in demand. Product prices tended to be relatively stable when U.S. supply varied, but instable when import prices varied. Import ratios were sensitive both to variations in U.S. supply and to variations in import prices. U.S. energy supply conditions and import price conditions were therefore the primary variables used in the analysis. Reference and pessimistic conditions of U.S. energy supplies and nominal and high levels of import crude oil/natural gas prices were defined in terms applicable to the two models and the two judgmental techniques.

These two supply conditions and two price levels could be combined to obtain four combinations, as shown in this two-by-two matrix.

		Energy Import Prices	
		Nominal	High
U.S. Energy Supplies	Reference Conditions	Case 1 (SRI) Case 3 (STPF)	
	Pessimistic Conditions		Case 2 (SRI) Case 4 (Exponential) Case 5 (Linear)

The combinations represented by the lower left-hand and upper right-hand boxes are consi[illegible] least likely to occur. The combinations represented by the upper left-hand and low rig[illegible]nd boxes are relatively likely, with the likelihood increasing from upper left to lower right. Product prices tended to increase and import ratios to decrease along the diagonal from left to right.

The combinations of U.S. supply conditions and import price levels for the five cases analyzed are indicated categorically by their positions in this matrix. The input assumptions defining the five cases are listed in Table C-1; more detailed quantitative input data for the three cases that used mathematical models (and therefore used quantitative inputs) are shown in Table C-2. The tables show the differences in the forms of inputs used by the five models. The SRI model inputs are mathematical relations, for a dynamic approach. Also, the SRI import price relations are asymptotic functions based on an economic analysis. The STPF model assumes that the import price remains constant.

Cases 1, 2, and 3 Assumptions

Table C-2 lists the assumptions that were used for Cases 1, 2, and 3.

Case 4 Assumptions

In the Case 4 projection, future trends in the various factors that can be expected to have significant effects on energy prices are assessed. The rates at which the prices of various energy forms will increase are estimated from the predicted behavior of the factors. The assessments and estimates were developed by the Naval Facilities Engineering Command; a brief summary of the various factors follows.

Coal

Coal price projections are based on amount of reserves, mining costs, transportation costs, nature of current and potential markets, availability of alternate fuels, and supportable price levels. Because of transportation costs, coal from a given area usually supplies nearby areas. The United States is currently capable of producing more coal than it consumes, and this capability is expected to continue for the next few years. However, with the expected shift from gas and oil to coal for electric power generation and improved coal liquefaction techniques to produce vehicular fuels, the growth in coal demand may require increased production capacity. The current steep climb in mine development costs, the expected increases in strictness of environmental preservation and reclamation requirements, and the projected increases in real wages for coal miners indicate an increase in coal prices relative to the overall cost of living. However, because of a large number of independent coal supplies, the price of coal should remain reasonable, compared with the prices of other available fossil fuels.

Petroleum

A decline in U.S. oil reserves and production rates without a corresponding reduction in demand will probably lead to continually increasing dependence on foreign resources. The cost of producing domestic synthetic oil will probably remain quite high. U.S. bargaining power resulting from the dependence of foreign oil producers' on U.S.

Table C-1. INPUT ASSUMPTIONS FOR PROJECTED

Case 1: SRI Energy Model
- Reference U.S. Supply Condition
  - Moderate increase in lifting costs with increasing cumulative production
  - Moderate synthetic oil/gas production costs
  - Price controls off all oil/gas (before 1980)
- Nominal Import Price Condition
  - $P_{crude} = 21 - 8(0.94)^t$
  - where P = constant 1975 dollars; and
  - t = years elapsed since January 1976

Case 2: SRI Energy Model
- Pessimistic U.S. Supply Condition
  - Rapid increase in lifting costs with increasing cumulative production
  - High synthetic oil/gas production costs
  - Price controls off all oil/gas (before 1980)
- High Import Price Condition
  - $P_{crude} = 26 - 10(0.94)^t$
  - where P = constant 1976 dollars; and
  - t = years elapsed since January 1976

Case 3: FEA Short-Term Petroleum Forecasting Model
- Base U.S. Supply Condition
  - Moderate finding rates
  - Moderate Alaska North Slope production rate (1.6 million bbl/day in 1977)
  - Annual 3 percent increase in domestic crude oil prices from $7.99/bbl (in constant 1976 dollars) through 1978 (per EPCA)
  - Current price controls on gas
- Base Import Price Condition
  - Import price remains at $13/bbl (in constant 1976 dollars) through 1978

Case 4: Exponential Price Increase Model
- Pessimistic U.S. Supply Condition
  - Declining U.S. production of oil and gas
  - U.S. oil and gas price controls gradually removed, ending in 1985
  - Escalating costs of U.S. coal production
  - Escalating costs of electric power plant construction and operation (both coal-fired and nuclear)
- High Import Price Condition
  - Gradually escalating import crude prices

Case 5: Navy Best Assessment (Weighted Assessment of Cases 1-4)
- Pessimistic U.S. Supply Condition
  - U.S. oil/gas resources at U.S. Geological Survey mean
  - U.S. oil/gas price controls extend beyond 1980
  - Continued slow expansion of U.S. coal production and utilization
  - Continued slow expansion of U.S. nuclear power development
  - Slow development and high costs for synthetic vehicular fuels
- High Import Price Condition
  - $P_{crude} = 13(1 + 0.04t)$
  - where P = constant 1976 dollars; and
  - t = years elapsed since January 1976

Table C-2. DETAILED INPUT ASSUMPTIONS FOR CASES 1, 2, AND 3

Factor	Year	Case 1	Case 2	Case 3
U.S. energy demand assumed growth rate (percent)	1975-1978			4.4-2.3
	1975-1985	2.3	2.3	
	1986-2000	2.5	2.5	
Import crude price (dollars per barrel) (Constant 1975 dollars)	1975	13.00	13.00	13.27
	1980	14.78	18.29	13.27
	1985	16.02	19.87	
	1990	16.98	21.09	
	1995	17.90	22.20	
	2000	18.40	22.90	
Import crude availability	1975-2000	No limit	No limit	No limit
Domestic crude price	1976-1979	a	a	b
	1980-2000			
Domestic crude availability		c		N/A
Synthetic production rate (million barrels per day)		d	d	None
Cumulative production (billions of barrels)		0	3.00	3.00
		70	7.60	8.00
		140	14.00	19.00
		210	32.00	N/A

[a] Same as for reports.

[b] 3 percent growth rate Energy Policy and Conservation Act (EPCA) incentive.

[c] Taken into account by and in the establishment of a relation between lifting cost and cumulative production.

[d] Developed by model through action of market demand/price interaction; not significant before 1990.

products, such as agricultural products, is limited. A long-term increase in world demand for oil and a long-term decrease in the world oil supply suggests that the world price of oil will continue to increase.

Natural Gas

The natural gas situation is similar to that of petroleum; a decline in U.S. reserves and production rates, without a corresponding reduction in U.S. demand, results in an increased demand for imports. Foreign gas supplies, however, are relatively limited, and the ratio of import to domestic prices is higher for gas than for oil. (Domestic gas price controls have kept the price of gas much lower than that of oil, on a per-Btu basis.) Based on supply availability projections, the known monetary needs of producers, and current price trends, it is expected that gas prices will be allowed to rise more rapidly than those of oil until about 1985. About this time, gas prices will have reached a slightly higher price level than oil prices, and both will continue to rise at the same rate.

Electricity

Fuel costs currently account for 25 percent to 50 percent of the cost of electricity to the consumer; the expected future increases in fuel costs will, of course, increase electricity costs. In addition, other costs, including fixed charges, depreciation, amortization, interest charged to construction, earnings applied to common equity, etc., are escalating rapidly. The embedded amortizable rate is currently about $200 per kilowatt of installed capacity, but essentially all existing plants must be replaced over the next 25 years. Power plant costs are now between $600 and $1,000 per kilowatt of installed capacity for coal-fired plants and appreciably higher for nuclear plants. Higher replacement costs, escalating fuel costs, and other continued growth costs will probably create an increase in the rate for electricity cost, which, for the next 25 years, will be appreciably higher than the increase rate for coal or oil.

Case 4 projections were formulated on the basis that cost increases of fuels and electricity can best be represented as constant percentages, resulting in exponential increases in constant 1976 dollars.

Case 5 Assumptions

The Case 5 projections were developed for the Navy Energy Office (OP-413) by a process similar to that used for Case 4. The projections are based on the general considerations that:

- The world situation, excluding the United States, with respect to energy production and consumption is:
  - The world in general and Western Europe in particular tend to allow high energy prices to limit consumption and do not permit environmental or safety considerations to severely limit production.
  - As a result, crude oil production in the North Sea, the USSR, and Mexico is developing at a much higher rate than expected; nuclear power development (including breeder reactor development) is proceeding at a high rate; and energy consumption practices in Europe and elsewhere continue to be conservative.
  - For these reasons, world crude oil prices (as set by nations now in OPEC, those—such as Mexico—that may join OPEC, and those—such as Britain, Norway, and USSR—that probably will not join) will probably remain near current levels, in constant 1976 dollars, except as gradually increasing lifting costs tend to raise prices. The decision of OPEC not to raise prices in June 1976 supports this belief.
- The situation of the United States, including Alaska, with respect to energy production and consumption is:
  - The United States appears likely to continue consumption encouraging energy price controls at least into the 1980s, although EPCA Phase II controls are now scheduled to end in 1979. Also, the United States is likely to continue emphasizing environmental and safety considerations in planning the development of both fossil fuel and more advanced energy sources, although the failure of the California Nuclear Initiative in June 1976 indicates that the strength of the environmentalists is not overwhelming.
  - As a result of environmental and political considerations, as well as technical problems, significant delays beyond currently set goals are likely to occur in

the completion of both the Alaskan pipeline and sufficient CONUS pipeline capacity to deliver Alaskan crude and the Elk Hills reserve crude to eastern U.S. refineries; in the development of U.S. offshore oil and gas sources; in the development and implementation of tertiary recovery techniques; in the expansion of coal production and utilization; in the development and implementation of synthetic fuel production techniques; and in the expansion of nuclear power production.

- For these reasons, it is probably that U.S. energy consumption will continue to grow at a rate exceeding the hoped for 2 percent per year; domestic production of energy will not keep pace; and distribution difficulties will result in temporary West Coast oil surpluses parallelled by chronic East Coast shortages.

Many factors, interacting in a complex matrix, will determine future energy prices. Some factors tend to cause prices to increase exponentially (at a constant percentage rate, which is a constantly increasing absolute rate). Other factors tend to cause prices to increase asymptotically (toward some limit, as a constantly decreasing absolute rate). Still other factors tend to cause prices to oscillate (to vary up and down in a short-term cyclic manner). Neither the future behavior of these factors, nor the manner in which they interact, has been or can be accurately established. However, it appears reasonable to expect that the resulting general trend of energy prices will be reasonably close to a linear increase (an increase at a constant absolute rate, in constant 1976 dollars). Figure C-5 shows this situation and the type of behavior projected for Case 5, the Navy's best estimate.

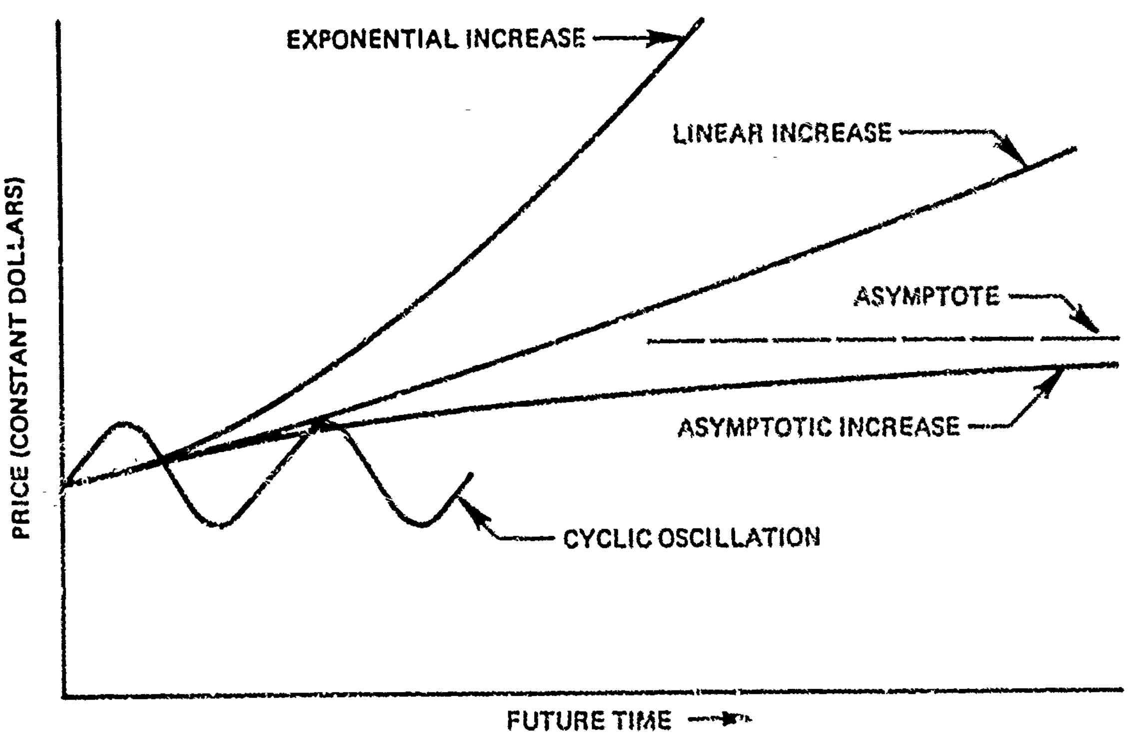


Figure C-5. GENERAL VARIATIONS IN PRICE INCREASES

Significant outputs of the model runs for Cases 1, 2, and 3 are listed in Tables C-3 and C-4. The percent of U.S. oil requirements that must be satisfied by imports, as predicted for each of these three cases, is tabulated in Table C-5. The predicted U.S. energy price behaviors resulting from the Case 4 and Case 5 analyses are shown in Table C-6. Utilization of the data in Tables C-3 through C-6 in calculating future Navy energy prices is discussed in the next section.

FUTURE NAVY ENERGY PRICES AND FUNDING REQUIREMENTS

The costs of the various forms of energy used by the Navy depend on U.S. and foreign energy prices and the fractions of the Navy's requirements that are satisfied by procurements from U.S. and foreign suppliers. In particular, DFSC standard prices for Navy liquid fuels can be expected to follow the price fluctuations of the crude oils from which the products are made. (The cost of the crude input to the refinery is 80 to 85 percent of the total cost of the refined product.)

Available data indicates that in FY 1975, continental U.S. (CONUS) suppliers provided 68 percent of the JP-5 and 20 percent of the DFM procured by DFSC, as well as 71 percent of the fuel oil, 88 percent of the purchased electricity, and virtually 100 percent of the natural gas consumed by the Navy's shore activities. If it can be assumed that (1) DFSC will continue its present policy of procuring from CONUS sources those, and only those, products that are to be consumed domestically; and (2) the worldwide geographic distribution of Navy energy consumption will remain about the same as in FY 1975, then the FY 1975 split between CONUS and foreign vendors for Navy energy products can be expected to continue without significant change. The average prices paid by the Navy for natural gas, electricity, fuel oil, and JP-5 will then continue to depend primarily on U.S. prices; the price paid for DFM will continue to depend primarily on the world price of crude oil.

The model output data given in Tables C-3 through C-6 have been used to calculate Navy energy prices. The procedure for Cases 1 and 2 follows. The domestic crude price is assumed to be \$7.66 per barrel in 1976 and to be equal to the assumed import price of 1980 and beyond. For 1976, an effective U.S. crude price is calculated as a weighted average of the domestic price (\$7.66 per barrel) and import crude price (\$13.00 per barrel), with weighting factors given by the fractions of U.S. consumption supplied from domestic (0.6) and foreign sources (0.4). The resulting effective U.S. price is \$9.80 per barrel. An effective DFSC crude price is then calculated as a weighted average of the effective U.S. crude price and the import crude price. DFSC standard prices for JP-5, DFM, and fuel oil are scaled from 1976 prices in proportion to the varying effective DFSC crude prices obtained by this process. Purchased electricity prices are obtained by applying a Navy price markup factor to the U.S. wholesale prices given in the model output tables. (Wholesale prices for FEA's supply and import conditions for the period beyond 1990 are determined by extrapolation from the 1980, 1985, and 1990 prices.)

Table C-3. SRI MODEL OUTPUTS (CASES 1 AND 2)

Factor	Actual 1975	Case 1—Reference Supply					Case 2—Pessimistic Supply				
		1980	1985	1990	1995	2000	1980	1985	1990	1995	2000
Imported oil (dollars/bbl)	11.10	12.88	14.12	15.08	16.00	16.50	16.40	18.00	19.20	20.30	21.00
U.S. wholesale prices, 1975 dollars											
Coal (dollars/ton)	16.40	19.80	22.60	24.10	26.20	27.40	20.73	23.29	25.16	27.03	27.54
Gasoline (dollars/bbl)	18.05	19.49	20.59	21.38	22.11	22.58	22.78	23.29	23.72	24.67	24.02
Distillate (dollars/bbl)	14.28	16.26	17.72	18.95	20.06	20.77	19.25	20.42	21.29	22.62	22.21
Pipeline gas (dollars/Tcf)	1.34	1.68	2.05	2.33	2.69	3.10	2.53	2.90	3.15	3.50	3.69
Electricity (dollars/Mwh)	25.11	25.96	26.03	26.00	26.13	26.23	27.02	26.97	26.65	26.58	26.34

Factor	Actual 1975	1980	1985	1990	1995	2000	1980	1985	1990	1995	2000
U.S. consumption, 10^{15} Btu/year											
Coal	12.7	17.7	23.2	27.2	33.0	38.3	18.5	23.9	26.4	33.8	39.5
Oil											
U.S. domestic	18.4	23.0	26.0	28.2	28.8	26.0	23.4	26.6	28.0	29.3	25.2
Imported	12.6	10.4	9.8	9.7	10.9	12.8	9.8	8.3	6.6	4.9	3.7
Shale-derived	0	0	0.3	0.9	2.8	6.4	0	0.4	3.0	5.8	13.5
Coal-derived	0	0	0	0.2	0.8	1.5	0	0	3.2	4.0	7.0
Gas											
U.S. natural	22.1	26.1	28.4	28.4	25.7	24.5	25.2	26.9	25.8	22.0	17.7
Imported	1.0	1.2	1.4	1.6	2.0	1.3	1.2	1.4	1.6	1.9	2.2
Synthetic	0	0	0	0.6	3.1	10.2	0	0	2.7	8.3	14.0
Nuclear	2.2	5.3	9.3	13.9	20.4	24.7	5.8	10.4	15.5	22.5	26.7
Hydro-solar-geothermal	1.0	1.1	1.2	1.3	1.4	1.4	1.1	1.2	1.3	1.4	1.4
Total U.S. consumption	70.0	84.8	99.6	112.0	128.9	147.1	85.0	99.1	114.1	133.9	150.9

Table C-4. FEA SHORT-TERM PETROLEUM FORECAST MODEL OUTPUTS[a] (CASE 3)
(Reference supply, nominal price)

Factor	1976	1977	1978
Import oil (dollars/barrel)	13.27	13.27	13.27
Domestic crude price (dollars/barrel)	7.99	8.23	8.48
Wholesale product price (dollars/barrel)			
Gasoline, vehicular	14.45	14.61	14.73
Kerosene-type jet fuel	12.03	12.24	12.42
Middle distillate	12.79	12.98	13.11
U.S. consumption (million of barrels/day)			
U.S. domestic	9.714	9.439	10.640
Imported	7.037	7.955	7.148
Total	16.751	17.394	17.788

[a]Adjusted to 1976 conditions and constant 1976 dollars.

Table C-5. U.S. OIL REQUIREMENTS SUPPLIED BY IMPORTED OIL
(Percent)

Case	1975	1976	1977	1978	1980	1985	1990	1995	2000
Case 1	40.6	–	–	–	31.1	27.1	24.9	25.2	27.4
Case 2	40.6	–	–	–	22.7	23.5	16.2	11.1	7.5
Case 3	–	42.0	45.7	40.2	–	–	–	–	–

Table C-6. PREDICTED U.S. ENERGY PRICE INCREASES (CASES 4 AND 5)

Product	Years	Case 4	Case 5
Coal	1976-2000	$(1.020)^t$	$(1 + 0.03t)$
DFM, JP-5, fuel oil	1976-2000	$(1.040)^t$	$(1 + 0.04t)$
Natural gas	1976-1985	$(1.120)^t$	$(1 + 0.10t)$
	1986-2000	$(1.040)^t$	$(1 + 0.10t)$
Electricity	1976-2000	$(1.055)^t$	$(1 + 0.06t)$

t = years elapsed since beginning of time period.

For Case 3 the procedure is the same as for Cases 1 and 2, with the exception that calculations are made only for 3 years—1976, 1977, and 1978—based on domestic crude prices as given in Table C-4. These prices escalate at 3 percent per year, the EPCA incentive rate. Weighted average crude costs are calculated for each year, rather than just for 1976, and price escalation multipliers are calculated for 1977 and 1978 from the weighted averages. The calculation of DFSC standard prices then proceeds as for Cases 1 and 2. The resulting Navy prices for DFM, JP-5, and fuel oil, as well as the intermediate results obtained from the various steps in the calculation, are listed in Table C-7 and the prices are plotted in Figure C-6.

The price escalations from Table C-6 are used to calculate Navy prices for Cases 4 and 5 from the 1976 prices used for Cases 2 and 3. The results of these calculations are included in the estimated price listed in Table C-7 and in Figures C-6 through C-9.

The Navy's Best Assessment of future energy requirements is shown in Table C-8. Table C-9 shows detailed estimated funding requirements for Navy energy for FY 1976-2000, both in constant 1976 dollars and in current dollars (assuming the EPCA 7 percent inflation rate remains constant). The constant dollar figures represent the product of the unit prices given in Table C-7 and the energy quantities given in Table C-8 for the five cases considered in the analysis. The resultant estimated funding requirements for Navy energy for FY 1976-2000, both in constant 1976 dollars and in current dollars (assuming the EPCA 7 percent inflation rate remains constant) are shown in Figures C-10 and C-11. In addition, projections for ship, shore, and air energy usage are illustrated in Figures C-12 through C-16.

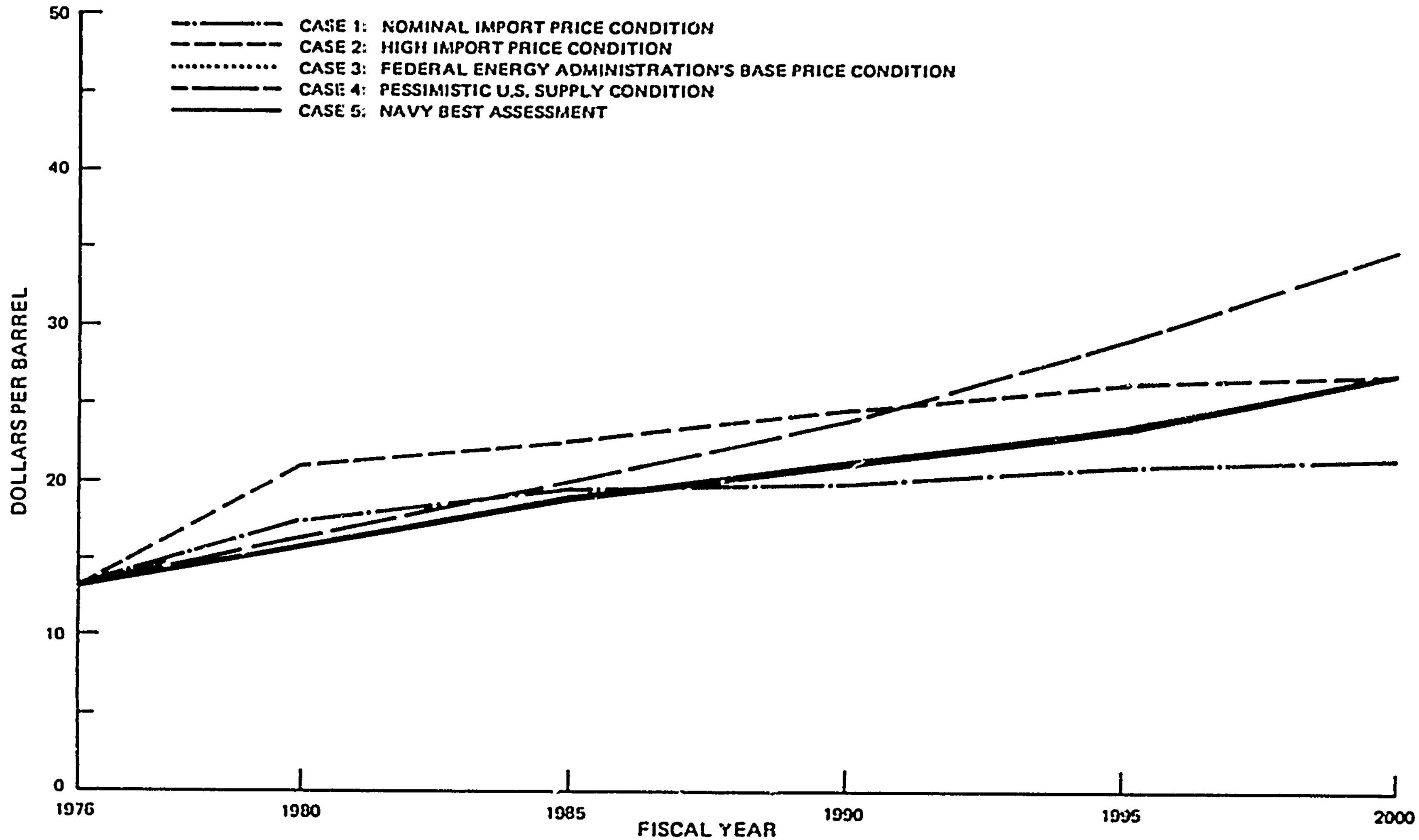
Table C-7. NAVY ENERGY PRICES
(Constant 1976 dollars; no inflation)

Factor	Case	FY 1976	FY 1977	FY 1978	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000
Import crude price (dollars/bbl)	1	13.00			14.78	16.02	16.98	17.90	18.40
	2	13.00			18.29	19.87	21.09	22.20	22.90
	3[a]	13.27	13.27	13.27					
Domestic crude price (dollars/bbl)	2	7.60[b]							
	3	7.99[c]	8.23	8.48					
Import fraction of crude mix at U.S refinery (dollars/bbl)	2	0.40[d]							
	3	0.40	0.45	0.38					
Weighted average cost of crude mix at U.S refinery (dollars/bbl)	2	9.80							
	3	10.10	10.50	10.30					
Weighted average worldwide cost of crude associated with product (dollars/bbl)									
JP-5 (68 percent CONUS)	1	10.82			14.78	16.02	16.98	17.90	18.40
	2	10.52			18.29	19.87	21.09	22.20	22.90
	3	11.12	11.39	11.25					
DFM (20 percent CONUS)	1	12.36			14.78	16.02	16.98	17.90	18.40
	2	12.36			18.29	19.87	21.09	22.20	22.90
	3	12.64	12.72	12.68					
Fuel oil (71 percent CONUS)	1	10.73			14.76	16.02	16.98	17.90	18.40
	2	10.73			18.29	19.87	21.09	22.20	22.90
	3	11.02	11.31	11.16					
Price escalation multipliers[e] relative to 1976 prices									
JP-5	1	1.0			1.366	1.481	1.569	1.654	1.701
	2	1.0			1.690	1.836	1.949	2.052	2.116
	3	1.0	1.024	1.011					
	4	1.0	1.038	1.077	1.161	1.399	1.686	2.031	2.448
	5	1.0	1.040	1.060	1.160	1.360	1.560	1.760	1.960
DFM	1	1.0			1.196	[illegible]	1.374	1.448	1.489
	2	1.0			1.480	1.608	1.706	1.796	1.853
	3	1.0	1.006	1.003					
	4	1.0	1.038	1.077	1.161	1.399	1.686	2.031	2.448
	5	1.0	1.040	1.080	1.160	1.360	1.560	[illegible]	1.960
Fuel oil	1	1.0			1.377	1.493	1.582	1.668	1.715
	2	1.0			1.705	1.852	1.966	2.069	2.134
	3	1.0	1.026	1.012					
	4	1.0	1.038	1.077	1.161	1.399	1.686	2.031	2.448
	5	1.0	1.040	1.080	1.160	1.360	1.560	1.730	1.960

Table C-7. NAVY ENERGY PRICES (Cont'd)

Factor	Case	FY 1976	FY 1977	FY 1978	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000
Estimated DFSC standard prices JP-5 (dollars/bbl)	1	14.91			20.37	22.08	23.39	24.66	25.36
	2	14.91			25.20	27.37	29.06	30.60	31.55
	3	14.91	15.27	15.07					
	4	14.91	15.48	16.07	17.31	20.86	25.14	30.29	36.50
	5	14.91	15.51	16.10	17.30	20.28	23.26	26.24	29.22
DFM (dollars/bbl)	1	14.24			17.03	18.45	19.56	20.62	21.20
	2	14.24			21.07	22.89	24.29	25.57	26.38
	3	14.24	14.32	14.28					
	4	14.24	14.78	15.34	16.52	19.91	23.99	28.90	34.82
	5	14.24	14.81	15.38	16.52	19.37	22.21	25.06	27.91
Fuel oil (dollars/bbl)	1	13.05			17.97	19.48	20.65	21.77	22.38
	2	13.05			22.25	24.17	25.66	27.00	27.85
	3	13.05	13.39	13.21					
	4	13.05	13.55	14.05	15.15	18.26	22.00	26.50	31.95
	5	13.05	13.57	14.09	15.14	17.75	20.36	22.97	25.58
Natural gas (dollars/BOE[f])	1	7.77			9.74	11.89	13.51	15.60	17.98
	2	7.77			14.67	16.82	18.27	20.30	21.40
	3	7.77	8.08	7.92					
	4	7.77	8.70	9.74	12.24	19.95	24.01	28.88	34.68
	5	7.77	8.55	9.32	10.88	14.76	18.65	22.53	26.42
Coal (dollars/BOE[f])	1	8.41			10.16	11.59	12.36	13.44	14.06
	2	8.41			10.63	11.55	12.91	13.87	14.13
	3	8.41	8.64	8.87					
	4	8.41	8.58	8.76	9.11	10.03	11.31	12.47	13.80
	5	8.41	8.66	9.91	9.42	10.68	11.94	13.20	14.47
Miscellaneous (dollars/BOE[f])	1	19.78			23.88	27.24	29.05	31.58	33.04
	2	19.78			24.98	28.08	30.34	32.59	33.20
	3	19.78	20.30	20.84					
	4	19.78	20.18	20.59	21.40	23.66	26.10	28.83	31.84
	5	19.78	20.37	20.97	22.15	25.12	28.09	31.05	34.02
Electricity (dollars/BOE[f])	1	13.17			13.60	13.64	13.62	13.69	13.74
	2	13.17			14.16	14.11	13.96	13.93	13.80
	3	13.17	13.69	13.43					
	4	13.17	13.86	14.67	16.30	21.34	27.84	36.47	47.62
	5	13.17	13.96	14.75	16.33	20.28	24.23	28.1[illegible]	32.13

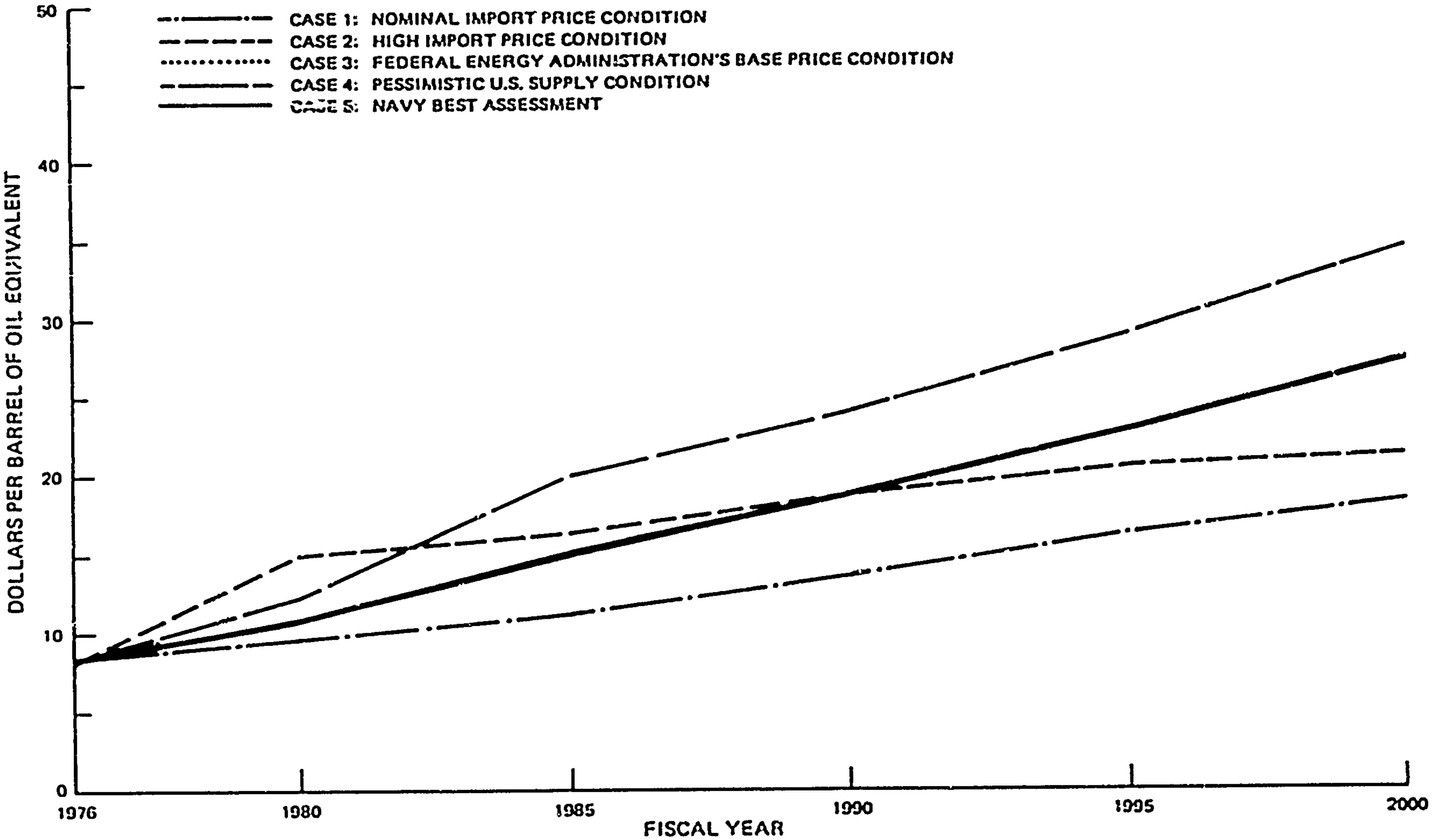
[a]Case 3 data are from Table C-4.
[b]Per EPCA.
[c]$7.66 per barrel plus $0.33 transport cost; EPCA incentive factor of 3 percent per year applied for FY 1977 and 1978.
[d]Source: DFSC Market Research.
[e]Cases 4 and 5 escalated in accordance with Table C-6
[f]Based on 1976 prices from NAVFAC.



SOURCE NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976.

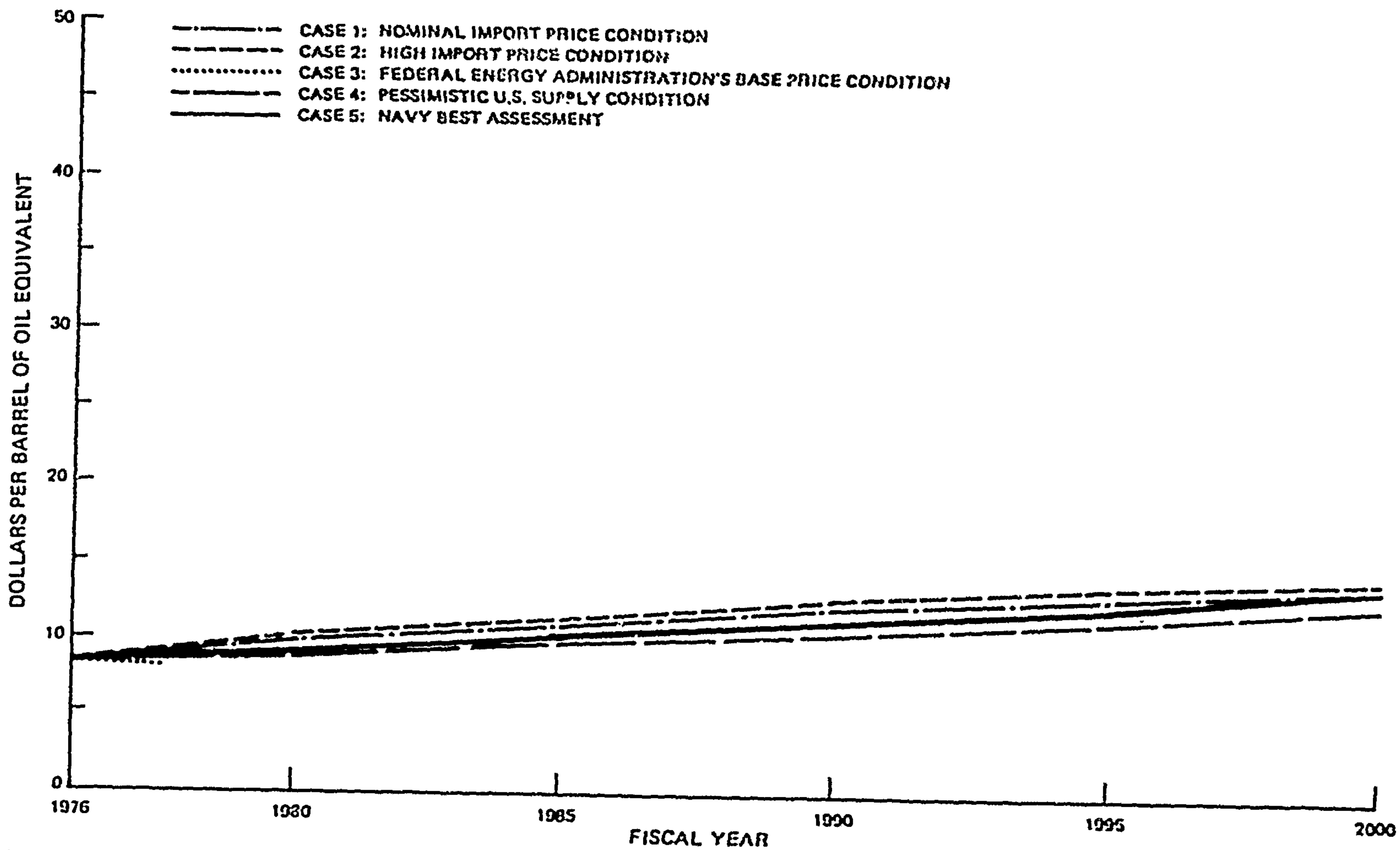
Figure C-6. NAVY DIESEL FUEL MARINE (DFM)* PRICE PROJECTIONS (CONSTANT 1976 DOLLARS)

*DFM, JP-5, and Fuel Oil are similar.



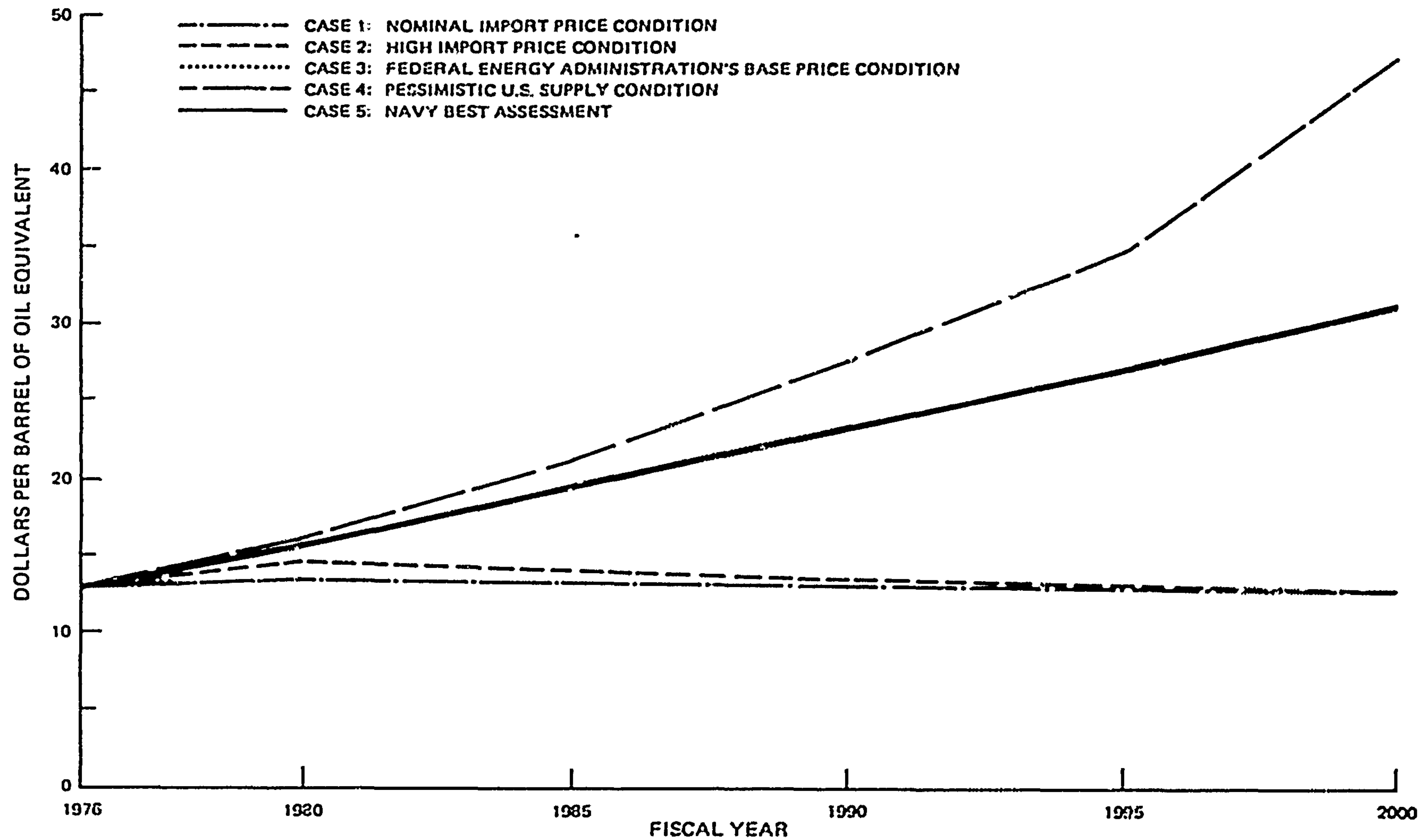
SOURCE. NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976

Figure C-7. NAVY NATURAL GAS PRICE PROJECTIONS
(CONSTANT 1976 DOLLARS)



SOURCE: NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976

Figure C-8. NAVY COAL PRICE PROJECTIONS
(CONSTANT 1976 DOLLARS)



SOURCE NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976.

Figure C-9. NAVY PURCHASED ELECTRICITY PRICE PROJECTIONS
(CONSTANT 1976 DOLLARS)

Table C-8. NAVY BEST ASSESSMENT ENERGY PROJECTIONS TO FY 2000
(MILLIONS OF BARRELS)

	FY 1976	FY 1977	FY 1978	FY 1979	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000	Total FY 1976-2000
Petroleum fuels	62.5	70.6	69.9	69.0	67.4	67.7	70.9	75.1	73.8	1751.3
Fleet	22.5	26.6	26.6	25.9	25.5	26.7	28.3	30.8	30.0	688.1
MSC	4.3	4.8	4.8	4.6	4.5	4.8	5.0	5.5	5.4	122.9
Aircraft	23.4	26.3	25.8	26.0	25.1	25.1	27.1	29.2	29.5	663.5
Shore heating oil	10.0	10.1	9.9	9.6	9.5	8.2	7.5	6.3	5.6	202.7
Ground support	2.3	2.8	2.8	2.9	2.8	2.9	3.0	3.3	3.3	74.1
Natural gas (MBOE)	5.0	4.7	4.5	4.1	3.9	2.6	2.2	2.0	1.8	73.6
Coal (MBOE)	0.4	0.4	0.4	0.6	0.9	2.5	3.1	3.3	3.5	54.3
Propane, purchased heat, other (MBOE)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	1.2	2.4	14.1
Purchased electricity (MBOE)	16.3	16.4	15.8	15.3	14.9	14.3	14.5	15.3	16.4	375.2
Navy total	84.5	92.4	90.9	89.3	87.4	87.4	91.0	96.9	97.9	2268.5

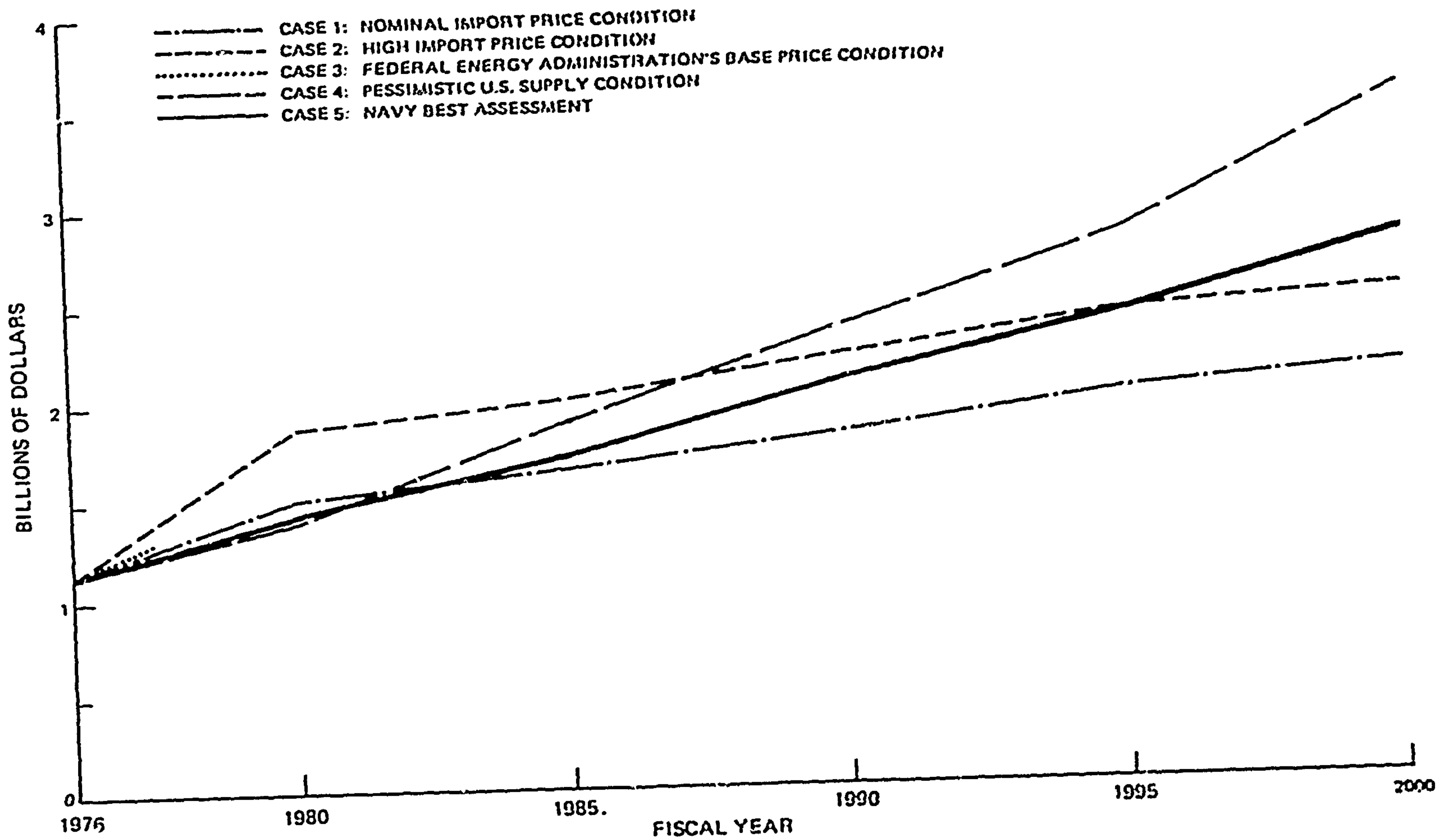
MBOE. Millions of barrel oil equivalent.

Table C-9. NAVY ENERGY FUNDING REQUIREMENTS
(Millions of dollars)

Fuel Cost	1976	1977	1978	1979	1980	1985	1990	1995	2000
CASE 1									
Ship fuels	382	–	–	–	511	581	651	749	750
Aircraft fuels	349	–	–	–	511	554	634	720	748
Shore heating oil	130	–	–	–	171	159	155	137	126
Shore ground support	33	–	–	–	48	54	50	68	70
Shore natural gas	39	–	–	–	38	31	30	31	32
Shore coal	3	–	–	–	9	29	38	44	49
Shore propane and miscellaneous	6	–	–	–	7	8	9	38	79
Shore purchased electricity	215	–	–	–	203	195	197	209	225
Total shore	426	–	–	–	476	476	488	527	581
Navy total in constant 1976 dollars	1,157	–	–	–	1,498	1,611	1,773	1,996	2,079
Inflated at 7 percent per year	1,157	–	–	–	1,964	2,962	4,572	7,218	10,545
CASE 2									
Ship fuels	382	–	–	–	632	721	809	928	934
Aircraft fuels	349	–	–	–	633	687	788	894	931
Shore heating oil	130	–	–	–	212	198	192	170	156
Shore ground support	33	–	–	–	59	66	73	84	87
Shore natural gas	39	–	–	–	57	44	40	41	39
Shore coal	3	–	–	–	10	30	40	46	49
Shore propane and miscellaneous	6	–	–	–	7	8	9	39	80
Shore purchased electricity	215	–	–	–	211	202	202	213	226
Total shore	426	–	–	–	558	548	556	593	637
Navy total in constant 1976 dollars	1,157	–	–	–	1,821	1,956	2,153	2,415	2,502
Inflated at 7 percent per year	1,157	–	–	–	2,387	3,596	5,551	8,734	12,691
CASE 3									
Ship fuels	382	450	448						
Aircraft fuels	349	402	389						
Shore heating oil	130	135	130						
Shore ground support	33	40	40						
Shore natural gas	39	38	36						
Shore coal	3	3	4						
Shore propane and miscellaneous	6	6	6						
Shore purchased electricity	215	225	212						
Total shore	426	447	428						
Navy total in constant 1976 dollars	1,157	1,299	1,265						
Inflated at 7 percent per year	1,157	1,390	1,448						

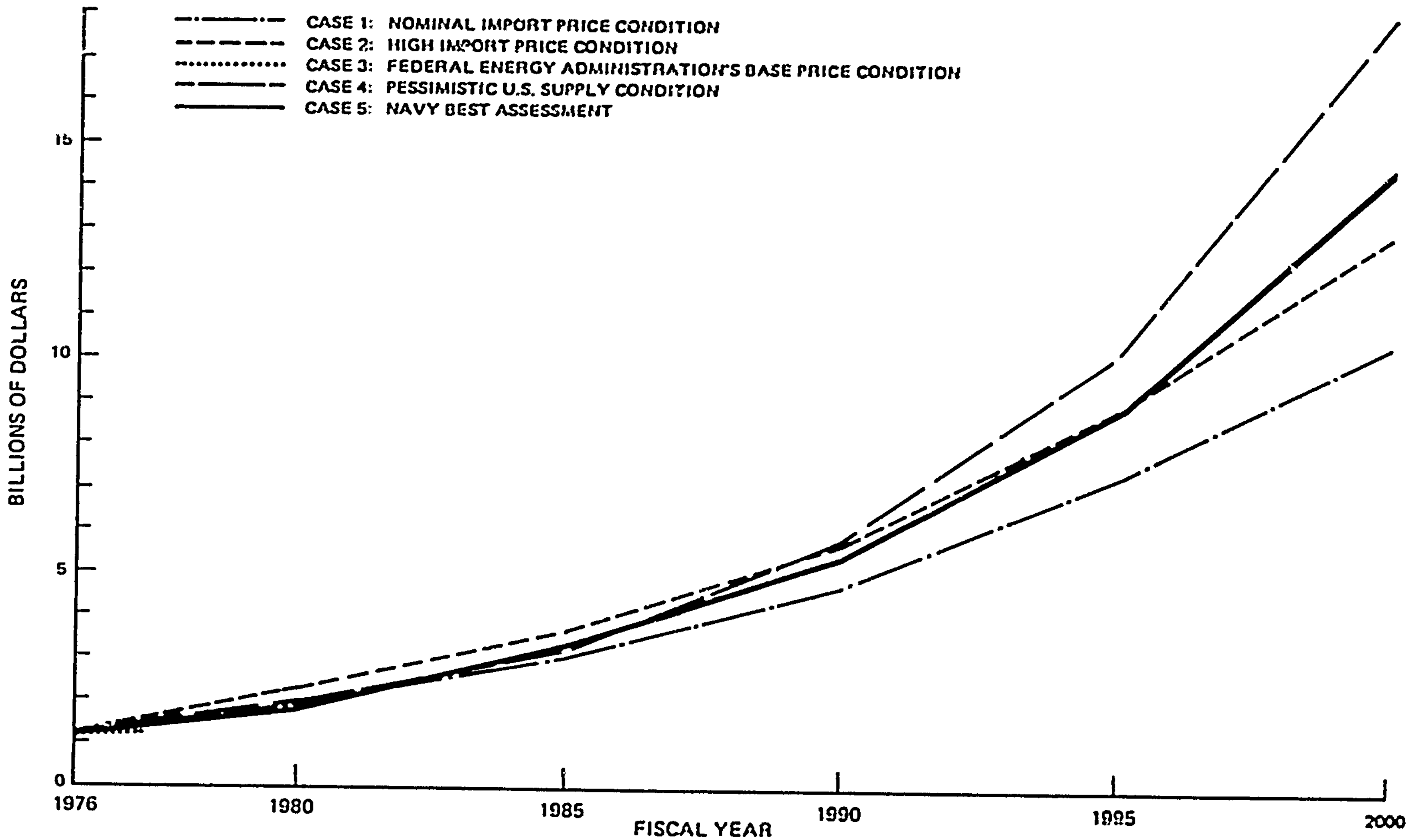
Table C-9. NAVY ENERGY FUNDING REQUIREMENTS (Cont'd)

Fuel Cost	1976	1977	1978	1979	1980	1985	1990	1995	2000
CASE 4									
Ship fuels	382	464	482	486	496	627	799	1,049	1,233
Aircraft fuels	349	407	415	434	434	524	681	884	1,077
Shore heating oil	130	136	139	140	144	149	164	166	177
Shore ground support	33	41	43	46	46	58	72	95	115
Shore natural gas	39	41	44	45	48	52	53	58	62
Shore coal	3	3	4	5	8	25	35	[illegible]	48
Shore propane and miscellaneous	6	6	6	6	6	7	8	38	76
Shore purchased electricity	215	227	232	237	243	305	404	557	781
Total shore	426	454	468	479	495	596	736	952	1,259
Navy total in constant 1976 dollars	1,157	1,325	1,365	1,399	1,425	1,747	2,216	2,885	3,569
Inflated at 7 percent per year	1,157	1,418	1,563	1,714	1,868	3,212	5,714	10,433	18,103
CASE 5 (Preliminary)									
Ship fuels	382	465	483	486	496	610	740	910	988
Aircraft fuels	349	408	415	434	434	509	630	766	862
Shore heating oil	130	137	140	140	144	146	153	145	143
Shore ground support	33	41	43	46	46	56	67	83	92
Shore natural gas	39	40	42	41	42	38	41	45	48
Shore coal	3	3	4	6	8	27	37	44	51
Shore propane and miscellaneous	6	6	6	6	7	8	8	37	82
Shore purchased electricity	215	229	233	238	243	290	351	431	527
Total shore	426	456	468	477	490	565	657	785	943
Navy total in constant 1976 dollars	1,157	1,329	1,366	1,397	1,420	1,684	2,027	2,461	2,793
Inflated at 7 percent per year	1,157	1,422	1,564	1,711	1,861	3,096	5,227	8,900	14,167



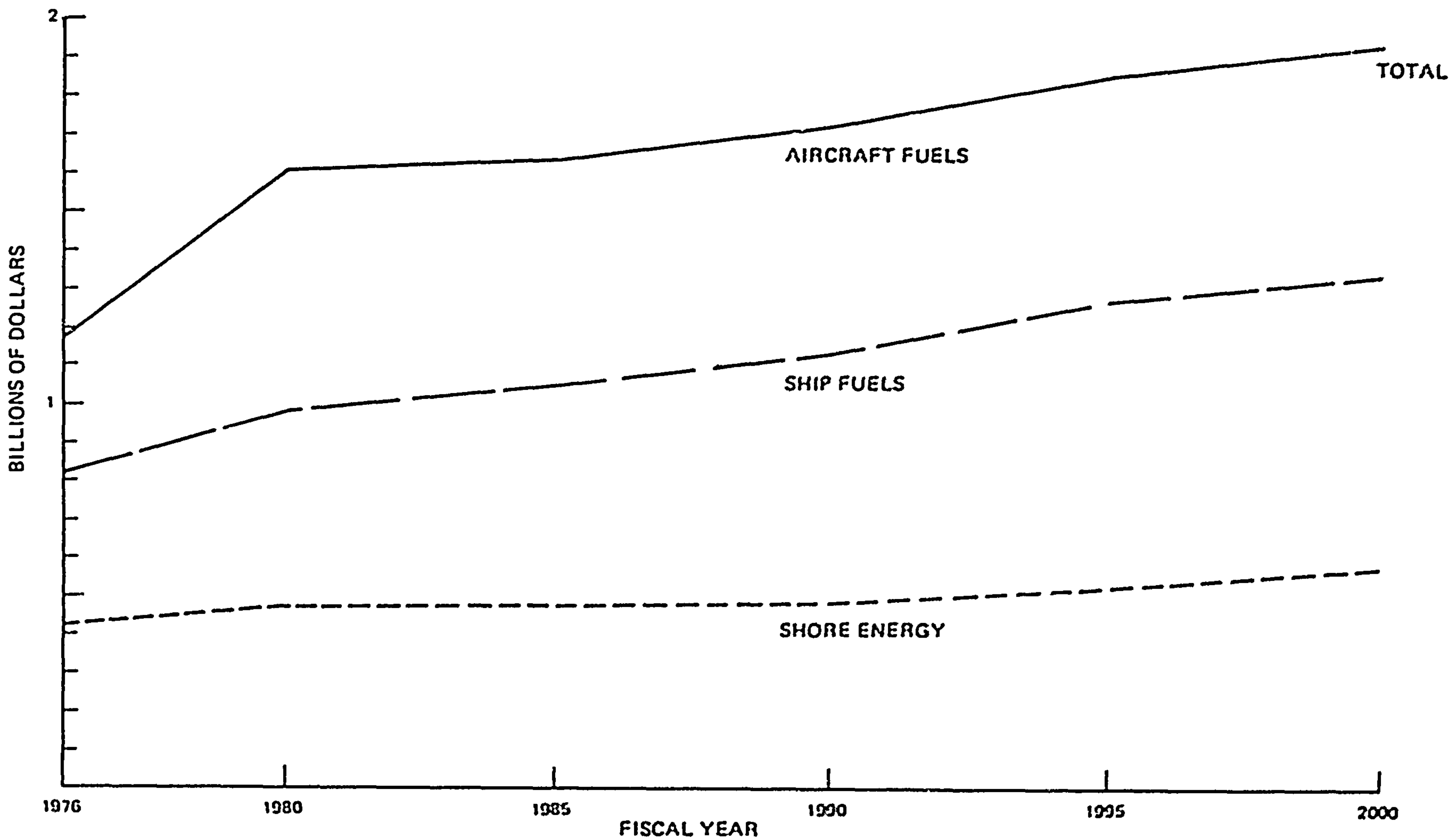
SOURCE. NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976

Figure C-10. NAVY ENERGY FUNDING REQUIREMENT, FY 1976-2000
COMPARISON OF CASES IN CONSTANT 1976 DOLLARS



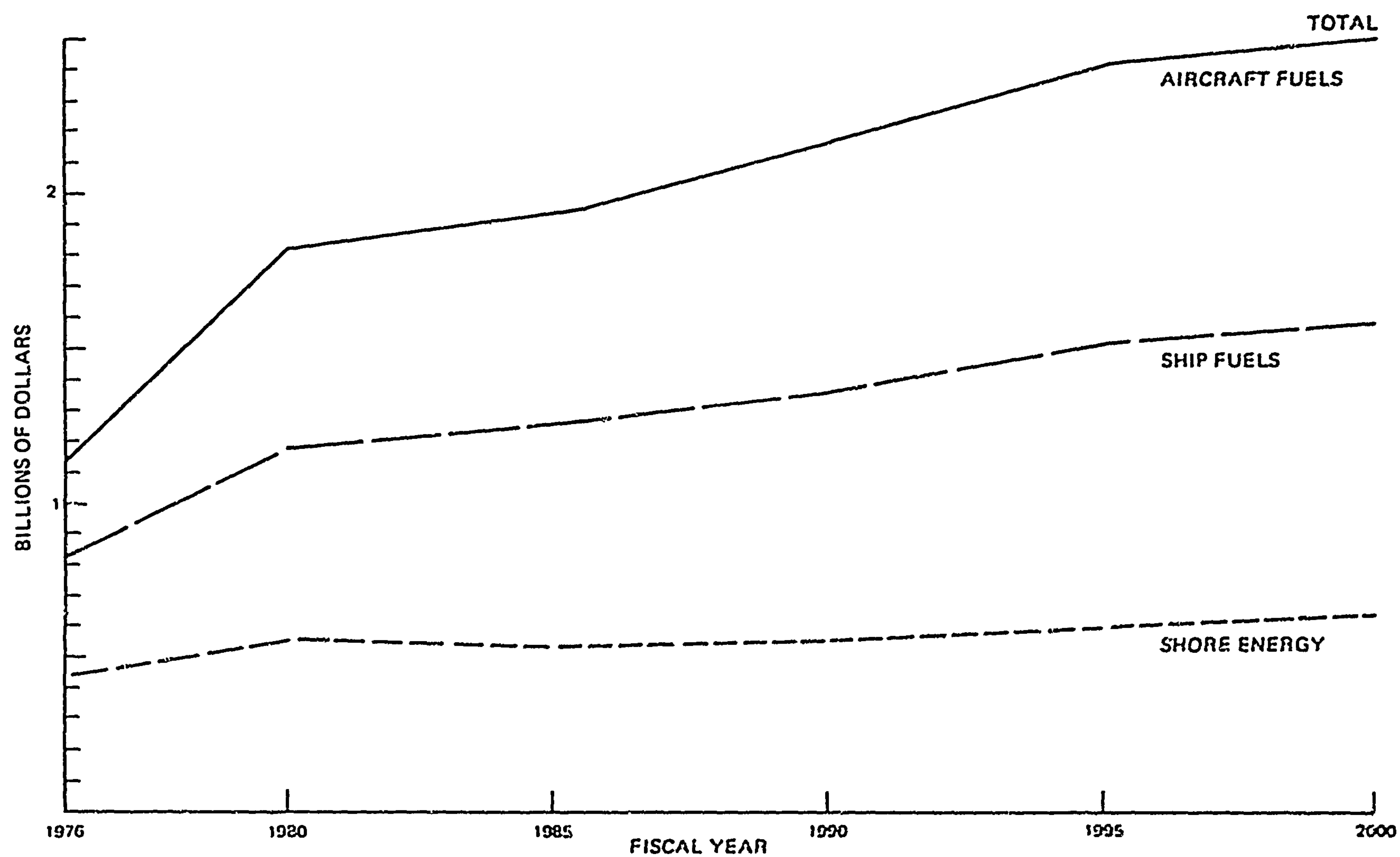
SOURCE NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976

Figure C-11. NAVY ENERGY FUNDING REQUIREMENTS, FY 1976-2000
COMPARISON OF CASES IN CURRENT YEAR DOLLARS
(7% ACTUAL INFLATION RATE)



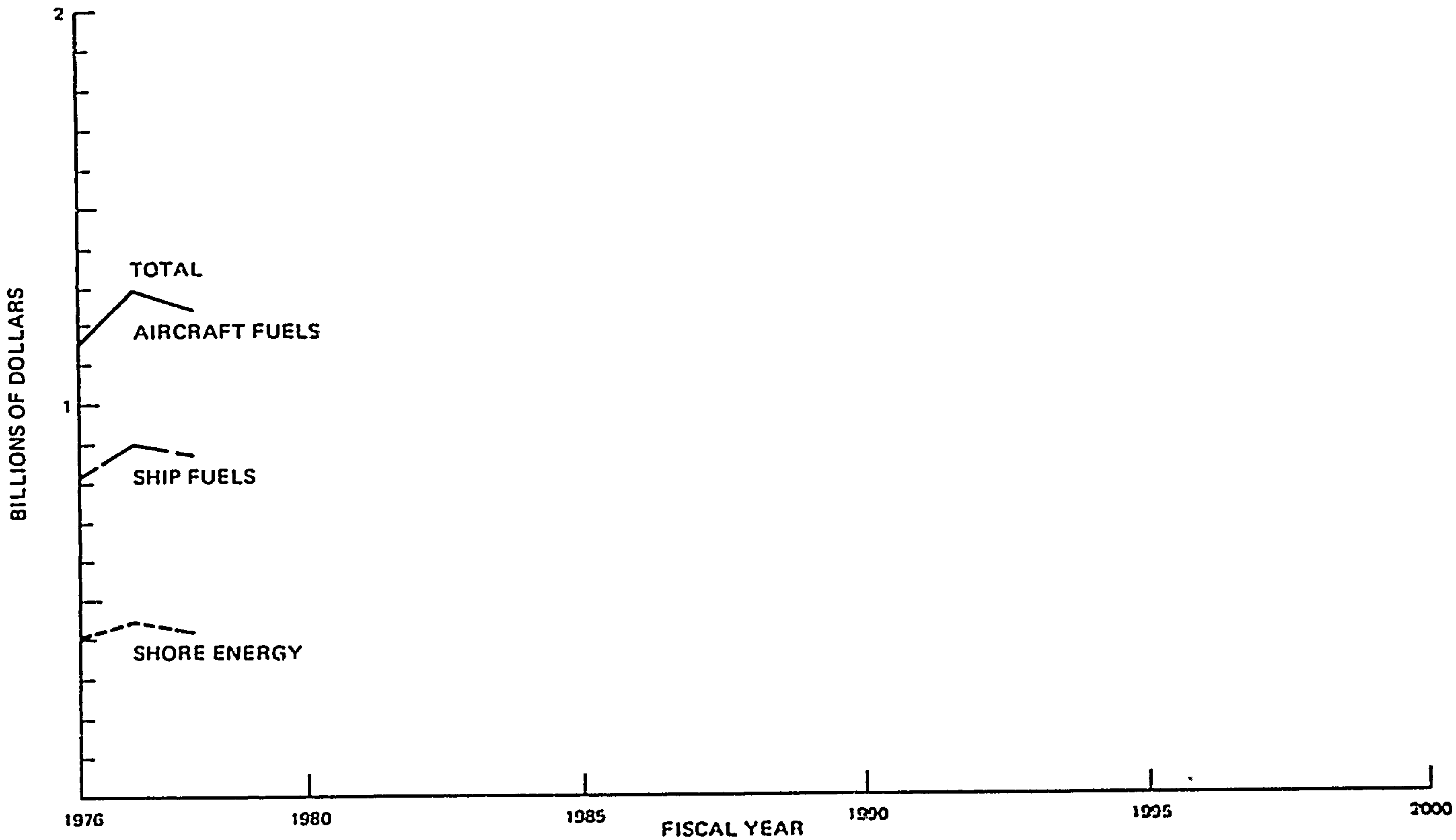
SOURCE NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976

Figure C-12. CASE 1
NAVY ENERGY FUNDING REQUIREMENTS, FY 1976-2000
(CONSTANT 1976 DOLLARS)



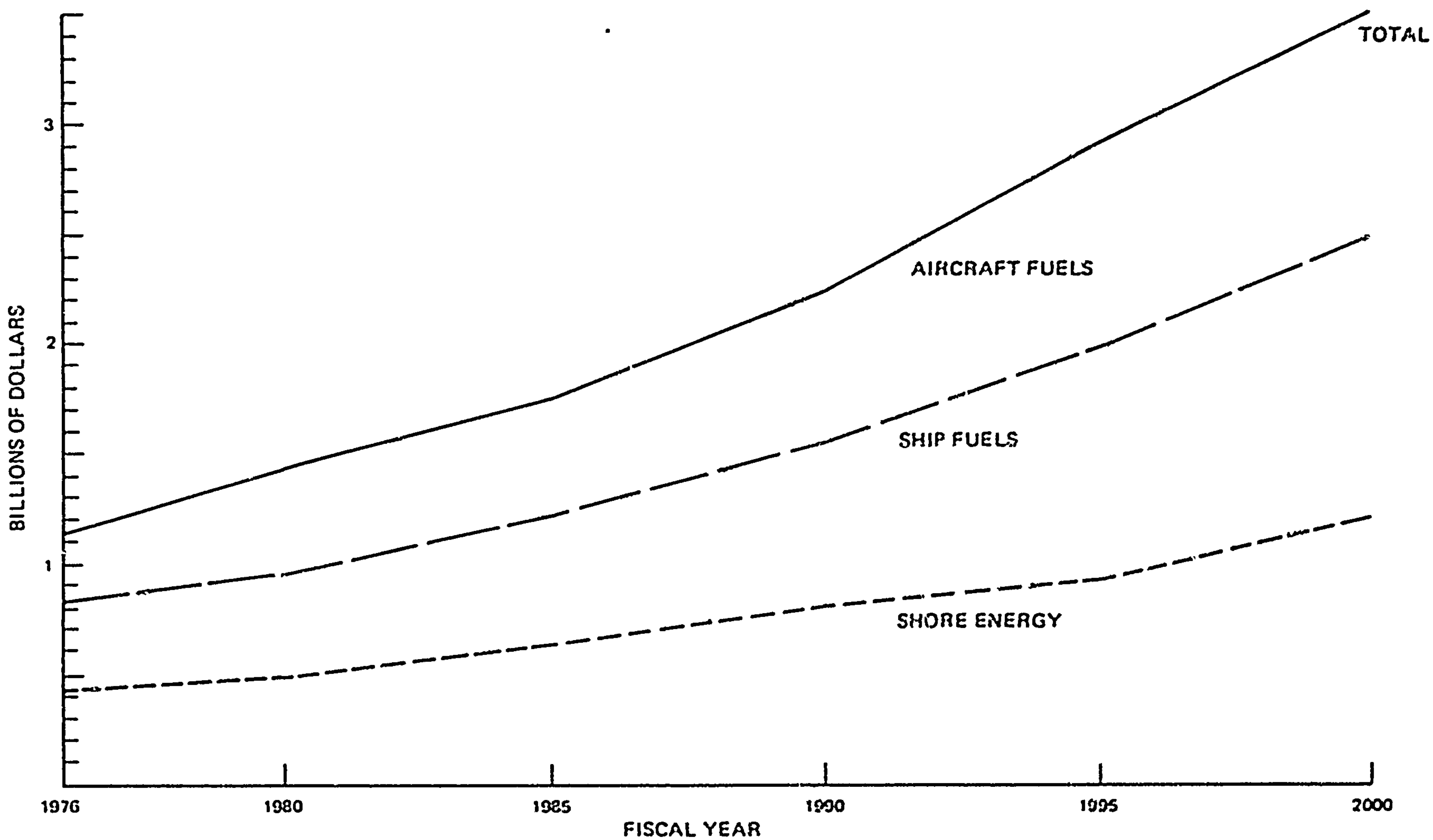
SOURCE NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976.

Figure C-13. CASE 2
NAVY ENERGY FUNDING REQUIREMENTS, FY 1976-2000
(CONSTANT 1976 DOLLARS)



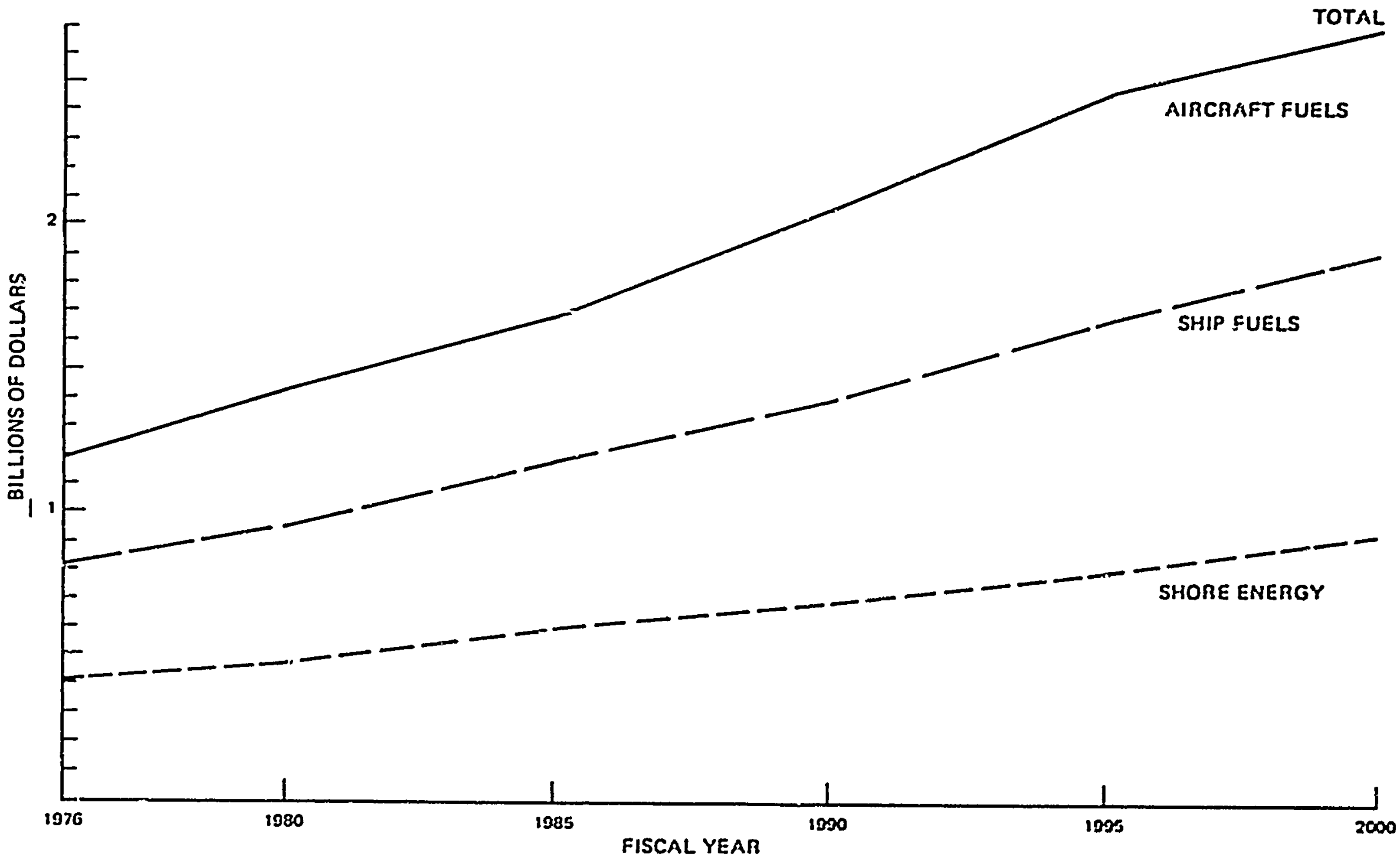
SOURCE. NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976.

Figure C-14. CASE 3
NAVY ENERGY FUNDING REQUIREMENTS, FY 1976-2000
(CONSTANT 1976 DOLLARS)



SOURCE: NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976.

Figure C-15. CASE 4
NAVY ENERGY FUNDING REQUIREMENTS, FY 1976-2000
(CONSTANT 1976 DOLLARS)



SOURCE. NAVY ENERGY USAGE PROFILE AND ANALYSIS SYSTEM, 1976

Figure C-16. CASE 5
NAVY ENERGY FUNDING REQUIREMENTS, FY 1976-2000
(CONSTANT 1976 DOLLARS)

APPENDIX D

ORGANIZATION AND MANAGEMENT OF NAVY ENERGY RESOURCES

APPENDIX D

ORGANIZATION AND MANAGEMENT OF NAVY ENERGY RESOURCES

INTRODUCTION

Because of the universal nature and magnitude of the current energy problem, Navy energy management and planning will be influenced by national and DOD-level energy-related activities and organizations. National programs and federal legislation will directly affect opportunities and resources available to the Navy. DOD energy policies and guidelines will directly influence the establishment of Navy energy planning priorities. The national energy planning environment is complex and demands communication and close cooperation among all agencies. Enacted and proposed national legislation relevant to Navy energy planning is summarized in Appendix E.

NATIONAL ENERGY ORGANIZATION

The federal government, through the Federal Energy Administration (FEA) and the Energy Research and Development Administration (ERDA) is providing leadership and assistance in creating a national energy climate and developing specific incentives needed to achieve national energy goals. These incentives include encouraging maximum industry involvement: initiating energy research, development, and demonstration efforts where industries efforts are unable to achieve national goals: and establishing a consistent developmental and regulatory framework that balances the early development of alternative technologies with other requirements (health, safety, environmental protection, and economic regulation).

Federal Energy Administration

FEA was established in May of 1974 to direct and conduct programs related to production, conservation, use, control, distribution, rationing and allocation of all forms of energy. The scope of these program activities and the future direction of FEA were expanded by the Energy Policy and Conservation Act (EPCA), which became law on December 22, 1975. EPCA establishes national policies on oil price and allocation controls, conservation measures, supply initiatives, and emergency authorities, such as contingency planning for protection against another embargo. Specific provisions of the act establish

- Standby authorities enabling the President to implement rationing and mandatory conservation plans to meet U.S. domestic needs and international energy commitments during a future supply interruption.

- A Strategic Petroleum Reserve to offset the impact of a supply interruption.
- Provisions for loan guarantees to develop new underground coal mines.
- Ceiling prices on domestic oil, while providing incentives to stimulate certain types of oil production.
- Energy conservation measures through voluntary and mandatory programs applicable to industry and state and federal governments.
- Energy efficiency standards for automobiles and energy efficiency targets for appliances and other consumer products.
- Expansion of a national coal conversion program to reduce U.S. demand for natural gas and petroleum products.

Through its various offices FEA sets the general tone and direction of the national energy policy. While its programs complement those of ERDA and DOD, there is little direct interface at this time between the Navy and FEA concerning energy research and development.

Energy Research and Development Administration

ERDA was created by Congress in October 1974 to assume the principal lead for federal energy research and development. Soon after its establishment, ERDA, in compliance with its legislative mandate, began to determine national energy research and development goals. These goals, listed below, were incorporated into ERDA's first report to Congress (known as ERDA 48) and have been more recently refined in ERDA 76-1.

- Expand the domestic supply of economically recoverable energy-producing raw materials.
- Increase the use of essentially inexhaustible domestic energy resources.
- Convert fuel resources efficiently into more desirable forms.
- Increase the efficiency and reliability of the processes used in energy conservation and delivery systems.
- Change consumption patterns to improve energy use.
- Increase end-use efficiency.
- Protect and enhance the general health, safety, welfare, and environment, as affected by energy.
- Perform basic and supporting research and technical services related to energy.

The significance of ERDA's program, as reflected by these goals, is that it establishes the priorities for all federal energy research and development. It is therefore critical that the Navy be aware of these priorities and that these priorities are reflected in the Navy's energy research and development efforts.

There are currently eight specific programs in which ERDA interfaces with DOD and the service departments. These eight programs, as required by law or defined by joint agreements, are outlined below.

Synthetic Fuels

Legislation – There is no general or specific legislation requiring joint efforts between ERDA and DOD. However, joint efforts have been undertaken between ERDA and the Navy as the result of the Navy's interest in shale oil.

Agreements – Recent letters (May 1976) have been exchanged between DOD and ERDA spelling out commitments for future joint efforts. No agreements exist between the Navy and the Army or Air Force, although these are essential for continued shale oil testing.

Photovoltaic Applications

Legislation – The Solar Energy Research, Development, and Demonstration Act of 1974 establishes what areas in solar energy should be addressed by ERDA and other agencies. Section 3 calls out photovoltaic power generation and Section 11 directs ERDA to enter into such arrangements and take such other steps as may be necessary or appropriate to provide for effective coordination of solar energy technology use within the federal government. DOD is interested in photovoltaic energy conversion technology because of its potential for promoting energy self-sufficiency on military bases.

Agreements – None have been formalized.

Ocean Thermal Gradients

Legislation – Same as for Photovoltaic Applications.

Agreements – None have been formalized, although the Navy has helped ERDA formulate the Ocean Thermal Energy Conversion (OTEC) program by making available to ERDA, on a consulting basis, Navy employees who are particularly knowledgeable in ocean technology and engineering.

Solar Heating and Cooling

Legislation – The Solar Heating and Cooling Act of 1974 (Public Law 93-409) establishes that ERDA and HUD shall initiate and carry out a program for the development and demonstration of solar heating systems for use in residential dwellings. It also calls upon the Secretary of Defense to contribute to the program by arranging for the installation of solar heating systems in a substantial number of federally owned houses.

Agreements – No formal memorandum of understanding has been signed. However, installation of solar heating and cooling units is underway in Navy, Army, and Air Force houses.

Ocean Farming

Legislation – The Solar Energy Research, Development, and Demonstration Act of 1974 covers this activity.

Agreements – No formal memorandum of understanding exists, although the American Gas Association and ERDA are jointly funding the Naval Undersea Center, San Diego, to conduct an ocean farm project. Giant kelp plants are to be used in this demonstration.

Fluidized-Bed Boiler Research

Legislation – No legislation has been enacted. The Navy's interest is in making base facilities available to ERDA to the mutual benefit of ERDA and the Navy.

Agreements – None are in effect.

Geothermal Research

Legislation – The Geothermal Energy Research, Development, and Demonstration Act of 1974 (Public Law 93-410), as amended, directs ERDA to prepare a comprehensive program definition of an integrated effort and commitment for effectively developing geothermal energy resources. The administrator, in preparing this program definition, is authorized to consult with other federal agencies and nonfederal entities.

Agreements – Although there are no formal ERDA/Navy agreements, joint planning efforts have resulted. One such effort is the utilization of the COSO thermal area at the Naval Weapons Center at China Lake, California.

DEPARTMENT OF DEFENSE (DOD) ENERGY ORGANIZATION

DOD involvement and participation in the national program is essential if the military services are to both support national goals and achieve an ensured supply of fuel and other energy sources required for accomplishment of their mission. Since DOD is the largest single user of energy, consuming approximately 3 percent of the nation's total, it can have a direct influence on many key programs. Further, it is necessary that DOD and individual military services recognize that they cannot remain idle while ERDA and other nondefense agencies solve their energy problems.

Defense Energy Task Group (DETG)

In September 1973, the Assistant Secretary of Defense (Installation and Logistics) (ASD(I&L)) acted on guidance received from the Deputy Secretary of Defense and established the DETG to conduct an in-depth analysis of the energy situation within DOD and to provide recommendations for improving the management of defense energy resources. DETG completed a preliminary analysis on 15 November 1973 and published a Phase I report, *Management of Defense Energy Resources.* Included in the report was a listing of many critical energy issues; the following policy guidelines were recommended.

- Concentrate on DOD missions and needs,
- Concentrate in areas of major payoff,

- Give high priority to natural hydrocarbon fuel conservation and synthetic fuel utilization,
- Maintain current knowledge of civil agency R&D,
- Encourage incorporation of DOD requirements into civilian programs sponsored by ERDA,
- Effect interservice coordination through DDR&E coordination committee.

After the Phase I report, a number of organizational measures were carried out within DOD. These included the establishment of a Defense Energy Council in OSD and a Directorate of Energy supported by an Energy Action Group to coordinate DOD actions to meet the energy supply crisis to work with FEA.

Defense Energy Policy Council (DEPC)

The function of DEPC, Figure D-1, is to develop broad energy policy guidelines. The council is chaired by the ASD(I&L) and is composed of representatives of the following:

OASD – (I&L)
OASD – (ISA)
OASD – (P&E)
OASD – (PA)
ODDR&E
Office of the Joint Chiefs of Staff (OJCS)
Defense Supply Agency (DSA)
Army
Navy
Air Force
Defense Fuel Supply Center (DFSC).

Directorate for Energy

The Directorate for Energy, Figure D-1, was established on 2 January 1974 as the primary DOD focal point for energy matters. The Director for Energy reports to the ASD(I&L) and serves as program manager for energy. His responsibilities include:

- Developing a Petroleum Logistics Policy,
- Representing and supporting the presentation of DOD positions on energy matters at Congressional hearings and interagency forums,
- Assisting in the development of DOD energy budgets,
- Serving as DOD principal point of contact on all energy matters and implementation of energy policy,
- Managing the DOD Energy Conservation Program,
- Monitoring the implementation of recommendations of the DETG report,
- Monitoring and recommending priorities of DOD R&D efforts in energy and energy-related matters,

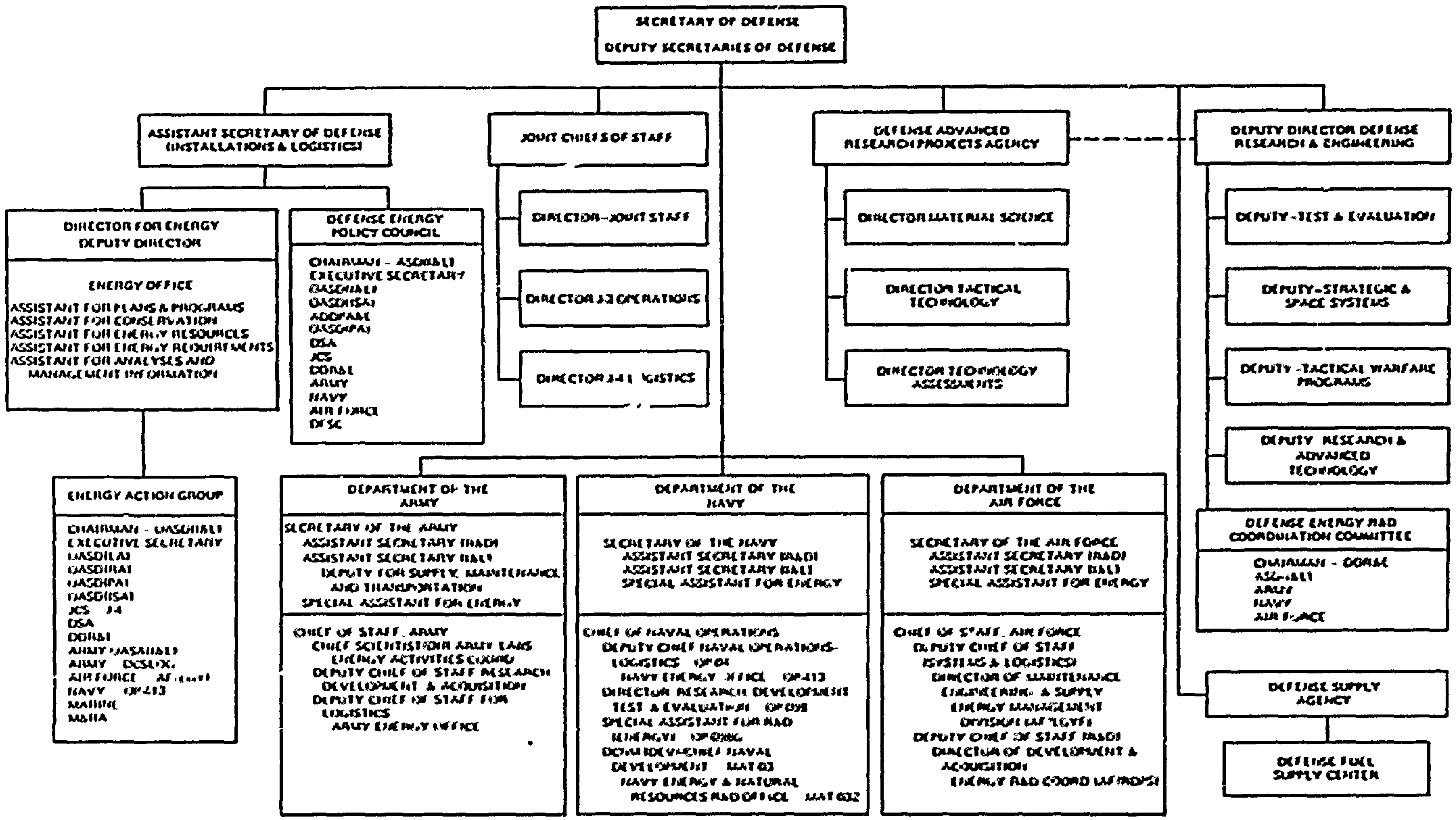


Figure D-1. DEPARTMENT OF DEFENSE ENERGY ORGANIZATION

- Preparing standby allocation programs for DOD.
- Monitoring current energy procurement and supply problems.
- Reviewing DOD requests for priority fuel supply allocations.
- Serving as secretariat for DEPC and Defense Energy Action Group.
- Developing the Defense Energy Information System (DEIS).

In carrying out its responsibilities, the directorate works closely with all DOD elements recognizing the energy-related responsibilities assigned to other DOD organizations. All DOD contacts on energy matters with other federal agencies are to be coordinated with this directorate to ensure that DOD policy and positions are presented in a consistent manner.

Defense Energy Action Group (DEAG)

DEAG, Figure D-1, was established to provide a framework for effectively coordinating the implementation of DEPC guidelines and a forum for information exchange. DEAG is composed of representatives from the Defense Staff, the services, DSA, and OJCS, and is chaired by the Director for Energy. DEAG serves in an advisory capacity to the Director for Energy.

Defense Energy R&D Coordination Committee

The Defense Energy R&D Coordination Committee is a special committee reporting to the Deputy Director Defense Research and Engineering (DDR&E). This committee, headed by a representative of the Engineering Technology Division, provides for coordination between DDR&E and the three military services. The Director, Navy Energy and Natural Resources R&D Office (MAT-03Z), is the Navy representative.

Defense Synthetic Fuels Steering Group (DSFSG)

DSFSG is an informal group created to coordinate synfuel research and development activities of the DOD services. The DSFSG will:

- Assess DOD objectives and programs in relation to other agency and industry programs having impact upon the production and utilization of synthetic fuels.
- Recommend DOD actions that will ensure timely acquisition and testing of synthetic fuels consistent with the need to minimize R&D costs and duplicate effort.
- Serve as a management team to perform the administrative duties required of specific programs undertaken by the group.

DSFSG consists of one member each from the Army, Navy, Air Force, and DFSC.

The Synthetic Fuels Steering Group meets on a continuing basis, as called by the chairman, and conducts coordinated planning for processing, refining, and testing oil-shale-derived synthetic crude.

Defense Supply Agency (DSA)

The Assistant Director, Plans, Programs, and Systems for the DSA serves as the principal focal point on energy supply matters. Specific staff elements have been designated to interface with the Directorate for Energy, OSD, with respect to

- Implementing Petroleum Logistics Policy as directed,
- Representing and supporting DOD positions on energy matters at Congressional hearings and interagency forums,
- Managing the DSA Energy Conservation Program,
- Recommending R&D priorities in energy and energy-related matters,
- Developing requirements for Federal Energy Office (FEO) allocation programs for DOD,
- Recommending solutions to current procurement and supply problems,
- Operating the DEIS and responding to DOD and FEO requests for supply information.

These actions have strengthened the coordination between DSA and the Directorate for Energy, which is important in view of DSA's role in the integrated management of fuel. DFSC is the principal subordinate activity of DSA for procurement and integrated management of fuel.

DEPARTMENT OF NAVY ENERGY ORGANIZATION

The Navy organization for energy planning is shown in Figure D-2. The principal energy-related functions are assigned by the Secretary of the Navy, Chief of Naval Operations, and the Chief of Naval Material to the

Special Assistant for Energy OASN (R&D),
Deputy Chief of Naval Operations (Logistics) (OP-04),
Director, Research, Development, Test and Evaluation (OP-098),
Deputy Chief of Naval Material (Development) (MAT-03),
Director of Naval Petroleum and Oil Shale Reserves.

Special Assistant for Energy, OASN (R&D)

The Special Assistant for Energy to the Under Secretary of the Navy reviews and coordinates energy planning activities from a policy standpoint and serves as energy scientific advisor to the Secretary of the Navy, ASN(R&D), ASN(I&L), and the principal staff elements.

Deputy Chief of Naval Operations (DCNO) (Logistics) (OP-04)

The DCNO (Logistics) is functionally responsible for providing policy coordination and guidance related to energy matters, with the exception of those technical and

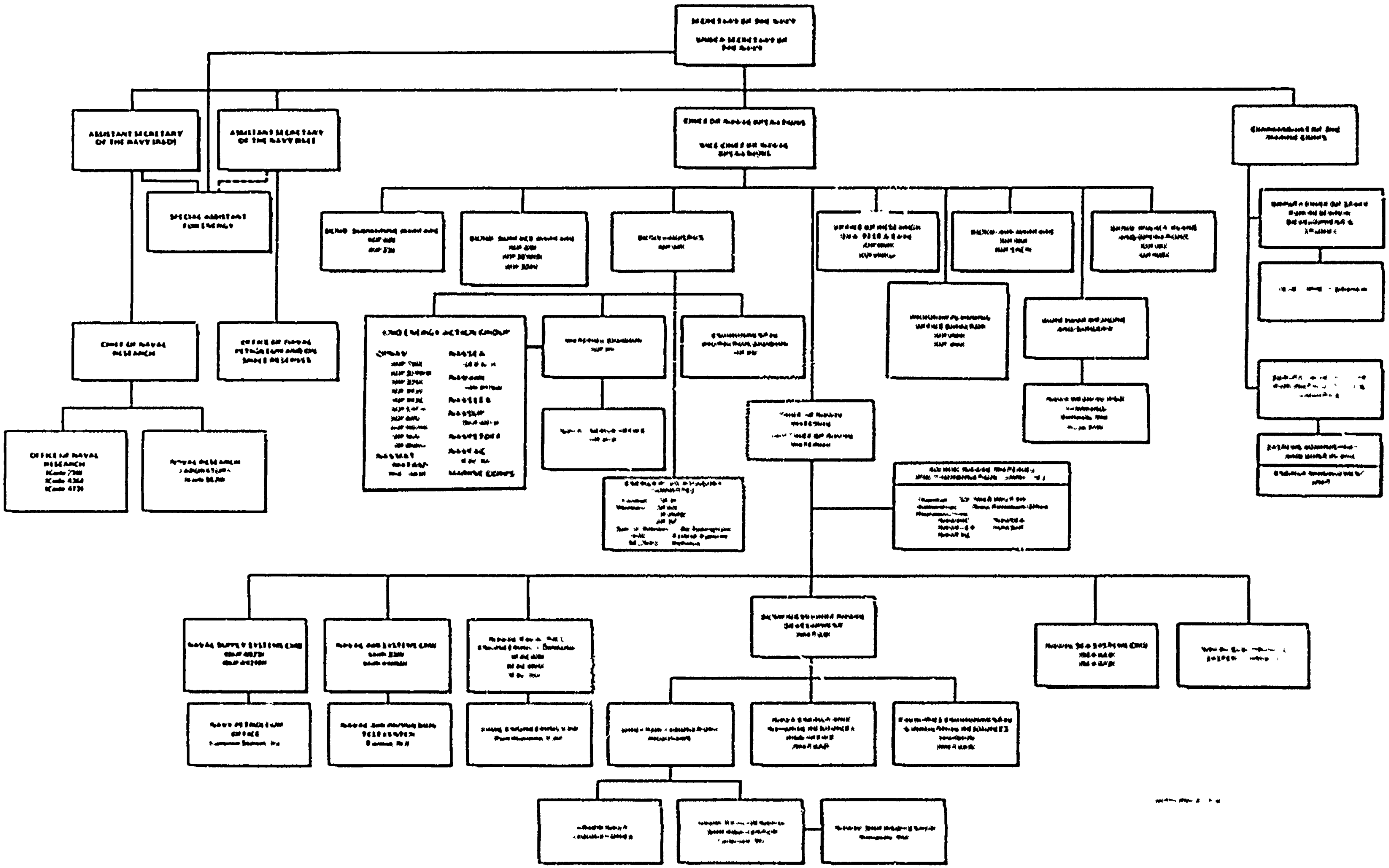


Figure D-2. DEPARTMENT OF THE NAVY ENERGY PLANNING ORGANIZATION management matters relating to the Naval Petroleum and Oil Shale Reserves. Systems development and implementation relating to conservation, standardization, requirements determination and analysis, facilities, and operations are coordinated by OP-04. The Director, Material Division (OP-41) provides the principal energy-related staff support. The Director serves as chairman of the CNO Energy Action Group, Figure D-2. The Navy Energy Office (OP-413) is responsible to the director for planning and monitoring efficient use of energy throughout the Navy.

Navy Energy Office (OP-413)

The Navy Energy Office provides policy guidelines on all matters pertaining to energy and energy conservation other than nuclear energy: assures the capacity of the Navy to provide energy resources to the operating forces and shore establishment as required; coordinates within the Office of the Chief of Naval Operations and acts as a central point of contact for Navy energy and energy conservation matters (other than nuclear energy, basic R&D, and matters under the cognizance of the Office of the Naval Petroleum and Oil Shale Reserves): and participates in functions of interdepartmental interest pertaining to energy matters.

This office has the responsibility for the following:

(1) Develop, coordinate, and recommend concepts, plans, policies, and systems with respect to the allocation, supply, and efficient use of energy resources within the Navy in response to requirements of the operating forces and shore establishment.

(2) Assess the Navy energy posture to include the monitoring of requirements and consumption with a view toward optimizing the requirement and consumption patterns in terms of available and projected energy resources.

(3) Coordinate the efforts of the Naval Material Command and various offices of the Chief of Naval Operations and assume the lead in developing a long-range energy plan for the Navy that will be reflected in the Navy Program Planning. The energy plan will be in consonance with the President's energy program and DOD directives such that future commercial energy resources will have applicability in its most economic form to Navy energy requirements.

(4) Act as a central point of contact for and recommend guidance to the operating forces on energy and energy conservation matters. Initiate, incentivize, and monitor energy conservation programs within the Navy by which the operational and support forces can effect net energy savings, while preserving an acceptable range of military capabilities.

(5) Compile current and future petroleum Prepositioned War Reserve Material Requirements (PWRMR), allocate CONUS PWRMR, monitor PWRMR theater levels, and coordinate worldwide inventory and facility requirements.

(6) Provide planning advice as pertains to the acquisition, construction, repair, modernization, maintenance, and disposal of Navy POL facilities.

(7) Develop overall policy for the Energy Conservation Program of the Navy to include establishment of program goals and evaluation of the Navy's energy conservation efforts.

(8) Act as the Program Sponsor for energy matters within the Office of the Chief of Naval Operations, such as the Energy Conservation Investment Program (ECIP), energy program budgets, and others as appropriate.

(9) Provide coordination with the Headquarters of the Marine Corps on all matters of energy and energy conservation which do or may impact on each others programs.

(10) Recommend specific energy conservation and management areas for review by the Inspector General of the Navy.

(11) Act as Program and Resource Sponsor for Navy Energy R&D projects to provide coordination in the application of energy R&D programs with regard to Navy mission and force requirements.

(12) Act as a member of the Defense Energy Action Group and as an energy adviser and sponsor of energy related studies concerning the availability, cost, and type of energy resources in the future.

(13) Act as adviser to the DCNO for Logistics who functions as a member of the Defense Energy Policy Council and the Chairman of the Department of the Navy Energy Conservation Task Group.

(14) Provide expertise and back-up for principal Navy witnesses appearing before OSD, OMB, and the Congress on energy-related matters.

(15) Advise all cognizant naval offices on energy implications of international political/military matters.

(16) Review and coordinate the development of the energy aspects of Navy plans and policies. Review all proposed new Navy programs to determine their impact on energy resources and their energy requirements throughout the life cycle of the program.

(17) Collaborate on tanker transportation aspects of POL logistics to ensure readiness of the Navy in peace and in war.

(18) Maintain active and close liaison with Commands, Bureaus, and Office of the Navy Department, and appropriate offices of the Army, Air Force, Department of Defense, and other governmental agencies, as necessary, to provide coordination and implementation of the foregoing functions.

Director, Research, Development, Test, and Evaluation, RDT&E (OP-098)

The Director, OP-098, carries out the CNO's RDT&E responsibilities and assists ASN(R&D) with coordination, integration and direction of the Navy RDT&E program. This office supervises and coordinates the POM submission and the RDT&E budget authorization request and FYDP update submission. The Director provides the principal supporting witness for ASN(R&D) before Congressional committees. This office makes presentations and provides descriptive summaries and other requested material to Navy staff elements to further explain and support specific R&D programs.

Energy Development Coordinator (OP-098G)

The Development Coordinator for all Navy Energy R&D programs, OP-098G, is responsible for accomplishing all RDT&E actions at the OPNAV level associated with the approved program. The main function of the development coordinator is to review energy-related R&D documents for accuracy, completeness, and applicability to total Navy R&D requirements. He ensures required R&D documents are submitted on time and that funding profiles reflect energy requirements that are attainable within the context of the total R&D budget. The Development Coordinator is the principal advisor to the Director, RDT&E, on energy R&D matters for both near-, mid-, and far-term R&D planning.

Director of Naval Petroleum and Oil Shale Reserves

The Office of Naval Petroleum and Oil Shale Reserves is a separate department of the Navy established by law in 1920. Through ASN(I&L), the Director is responsible to and authorized to act for the Secretary of the Navy on all matters pertaining to the Naval Petroleum and Oil Shale Reserves

Deputy Chief of Naval Material (Development) (MAT-03)

The Deputy Chief of Naval Material/Chief of Naval Development (MAT-03) provides staff assistance to the Chief of Naval Material in the areas of development, test, and evaluation; supervises and develops management policies for administering facilities and resources available within the Naval Material Command for the execution of RDT&E programs; and coordinates the exercise of command over major naval laboratories.

The Chief of Naval Development coordinates the Navy exploratory development program, providing staff assistance to the ASN(R&D) in appraising technical, economic, and logistics aspects of Navy development.

Responsibility for energy R&D program planning and direction has been placed in the Navy Energy and Natural Resources R&D Office (MAT-03Z). This responsibility includes coordination of the energy R&D programs of the Naval Systems Commands and CNM-commanded laboratories.

Navy Energy and Natural Resources R&D Office (MAT-03Z)

The mission of the Navy Energy and Natural Resources R&D Office (short title—Navy Energy R&D Office) is to supervise the planning, execution, and appraisal of the Naval Material Command energy and natural resources exploratory, advanced, and engineering development programs. This program supervision, responsive to Chief of Naval Operations and Chief of Naval Material, includes budget planning and review.

The Energy R&D Office sponsors experiments and demonstrations in the application of advanced technology emerging from the energy R&D programs sponsored by the Navy, other military departments, other federal agencies, and private industry. These efforts are directed toward accelerating the application of these technological developments in the Navy.

In fulfilling the mission of the Navy Energy R&D Office it will be necessary for the staff to review all Navy programs involving energy technology evolution or applications for the purpose of assessing the feasibility of achieving program goals, the validity of the technical approach, the adequacy of management and funding to accomplish these goals, the viability of proposed schedules, and the progress and future prospects of the programs. The Office will:

(1) Provide the Chief of Naval Materials and the Chief of Naval Development with balanced appraisals of energy technology programs. The Office will make recommendations to the Chief of Naval Material and the Chief of Naval Development regarding needed areas of development and will thus provide the basis for an integrated Navy program.

(2) Provide technological and reference services for all Navy programs previously described. In this context, the Office will serve as the Chief of Naval Material and the Chief of Naval Development designated point of contact for all Navy energy technology programs.

(3) Assist in answering questions on energy matters directed to the Chief of Naval Material and the Chief of Naval Development by higher authority and assist in like manner in advising higher authority on such matters, and will coordinate these efforts closely with the managers of the projects involved.

(4) Maintain a current knowledge of and association with all energy and natural resources research and development. In addition the Director and his assistants will be available as scientific and technical advisors in the area of energy technology to the various Project Managers. The Director will provide day-to-day

assistance in the Headquarters staff coordination of Navy energy programs and ensure necessary liaison and coordination with the Navy Energy Branch (OP-413), the Energy Development Coordinator (OP-098G), Naval Material Command Program Managers and Systems Commands.

APPENDIX E

FEDERAL ENERGY LEGISLATION

APPENDIX E

FEDERAL ENERGY LEGISLATION

INTRODUCTION

The Navy's energy plan must be viewed in the context of DOD's energy program, as well as that of the nation's overall energy policy. This section addresses the Navy's relationship to overall energy policy and summarizes proposed and enacted legislation that is pertinent to the Navy's energy plan.

The first category is comprised of the public laws that formulate the general energy policy of the United States, which include:

- Energy Reorganization Act,
- Federal Nonnuclear Energy Research and Development Act,
- Energy Policy and Conservation Act.

The second category represents those public laws that mandate or define the Navy's involvement in the national energy program:

- Defense Production Act,
- Solar Heating and Cooling Demonstration Act,
- Geothermal Energy Research, Development, and Demonstration Act,
- Solar Energy Research, Development, and Demonstration Act,
- Naval Petroleum Reserves Production Act.

The final category is a survey of the most significant proposed legislation, which if enacted, will directly impact on the Navy's energy plan:

- Petroleum Industry Competition Act (S. 2387),
- Energy Information Act (S. 1864),
- Electric Vehicle Research, Development, and Demonstration Act (H.R. 8800),
- Ground Propulsion Systems Act (H.R. 7231).

PUBLIC LAWS ESTABLISHING NATIONAL ENERGY POLICY

Energy Reorganization Act of 1974 (Public Law 93-438)

This law basically provides for the creation of the Energy Research and Development Administration and the redefinition of other federal agencies' energy-related activities.

The significance of this act to the Navy is that it authorizes ERDA to coordinate all direct federal activities relating to energy research and development. It therefore establishes a link between the Navy's R&D effort and the national programs funded by ERDA.

Federal Nonnuclear Energy Research and Development Act of 1974 (Public Law 93-577)

This act establishes policy guidelines for ERDA and provides authority for the development of a comprehensive national program to conduct nonnuclear research, development, and demonstration. Because it provides the basic mandate for nonnuclear energy R&D legislation, Public Law 93-577 has a significant impact on the Navy's energy program.

Included in this law are provisions for

- Short-term, middle-term, and long-term comprehensive planning,
- Federal assistance for RD&D through joint government/industry projects, contracts, federal purchases or guaranteed prices, federal loans, and incentives for individual inventors,
- Protection of environmental and water resources,
- Antitrust and patent regulations.

Energy Policy and Conservation Act of 1975 (Public Law 94-163)

The Energy Policy and Conservation Act (EPCA) of 1975 represents the most recent legislative contribution to the nation's energy policy. The provisions of this act contain directives and regulations covering a broad spectrum of energy issues, some of which specifically influence the Navy's energy-related functions.

Of particular interest to the Navy is the authority granted under Title I, Part B of EPCA which provides for the establishment of a Strategic Petroleum Reserve (SPR). The creation of this 4-part reserve would provide an additional source of petroleum for DOD in the event of a national emergency. DOD presently functions with a limited operating reserve and the prepositioned war reserve, which is only to be used in the event of war. DOD's use of the SPR would require that the Defense Production Act be evoked.

Under EPCA the Early Storage Reserve (ESR) would, by 1978, contain at least 150 million barrels of petroleum as the predecessor to the SPR. The act also provides that, by 1982, the SPR would reach its full capacity of approximately 500 million barrels.

Projected petroleum storage in a proposed Industrial Petroleum Reserve (IPR) has been established by FEA as being approximately 185 million barrels. Creation of the IPR is to be at the discretion of FEA, based on studies of the industry's needs.

Regional Petroleum Reserve (RPR) storage is part of, rather than an addition to, the quantities of petroleum required in the SPR.

The Navy, as a consumer of petroleum and petroleum products, is directly impacted by the amendments to the Emergency Petroleum Allocation Act contained in Title IV of EPCA. The new oil price policy contained in EPCA establishes a pricing formula for domestically produced crude oil that provides for an initial crude oil price roll back and authorizes gradual increases in the prices received by domestic producers over a 40-month period. The President is given broad flexibility to set prices for various categories of oil production, including the authority to recommend to Congress that various products be decontrolled.

Any increased costs that may occur as the result of these new pricing policies must be distributed in direct proportion to the costs of No. 2 oils, aviation fuel of a kerosene or naphtha type, and propane-produced crude oil, unless the President justifies deviation from this pass-through policy.

Because of the inevitable price hikes brought about by this legislation, the Navy's energy costs will greatly increase, along with the Navy's need for intensified energy efficiency and conservation.

PUBLIC LAWS DIRECTLY AFFECTING THE NAVY'S ENERGY PROGRAM

Defense Production Act of 1950, As Amended (Public Law 81-774)

To facilitate the production of goods and services necessary for national security, this act authorizes the

- Establishment of a system of priorities and allocation for materials and facilities and provides for the requisition of such materials and facilities.
- Expansion of productive capacity and supply.
- Development of price and wage stabilization, settlement of labor disputes, and the strengthening of controls over credit.

The President is authorized to invoke these provisions when, in his estimation, the situation warrants such action.

The Navy's fuel requirements are protected by the Defense Production Act. Certain DOD actions are authorized by this bill to guarantee availability of necessary fuels and equipment.

Solar Heating and Cooling Demonstration Act of 1974 (Public Law 94-409)

As amended by the Federal Nonnuclear Energy Research and Development Act, Public Law 93-409 provides for the demonstration of solar heating and cooling technologies for use in residential dwellings. This is to be administered by ERDA and implemented through the Department of Housing and Urban Affairs and DOD.

The Secretary of Defense is directed by the act to arrange for the installation of solar heating and cooling systems, procured by ERDA, in a substantial number of residential dwellings located on federal property. The dwellings are to be of sufficient number in different geographic areas under varying climatic conditions to constitute a realistic and effective demonstration program. The program is to continue for a period of five years under the performance criteria established by ERDA.

Geothermal Energy Research, Development, and Demonstration Act of 1974 (Public Law 93-410)

As amended by the Federal Nonnuclear Energy Research and Development Act, Public Law 93-410 directs ERDA to initiate "a research and development program for the purpose of resolving all major technical problems inhibiting the fullest possible commercial utilization of geothermal resources in the United States."

A part of the legislative directive addresses consideration of "cooperative agreements with other Federal agencies for the construction and operation of facilities to produce energy for direct federal consumption." This provision is of particular importance to the Navy's energy program because of the known geothermal area where the COSO Geothermal Project on the naval weapon range at China Lake, California is partially funded by ERDA.

Solar Energy Research, Development, and Demonstration Act of 1974 (Public Law 93-473)

As amended by the Federal Nonnuclear Research and Development Act of 1975, Public Law 93-473 provides for ERDA initiation of a research, development, and demonstration program to resolve the major technical problems inhibiting commercial utilization of solar energy in the United States.

The technologies to be addressed or dealt with in the research and demonstration progr. , include:

- Direct solar heat,
- Thermal energy conversion,
- Conversion of cellulose and other organic materials to energy or fuels,
- Photovoltaic processes,
- Ocean thermal gradient conversion,
- Wind power conversion,
- Solar heating and cooling of housing and commercial buildings,
- Energy storage.

The law provides that ERDA, "acting through the appropriate Federal agencies," may establish demonstration projects for the testing of technologies as well as to provide energy for "direct federal utilization."

The Navy's Ocean Thermal Energy Conversion (OTEC) Program and the Navy's interest in application of wind power, energy storage, and photovoltaic processes and bioconversion, provide points for interaction and technology exchange between ERDA and the Navy under the provisions of this act.

The Naval Petroleum Reserves Production Act of 1976 (Public Law 94-258)

Chapter 641 of Title 10 of the United States Code is the source of federal regulations governing the Naval Petroleum Reserves. This chapter reflects the original act of 1920 that gave the Navy jurisdiction over the reserves; subsequent amendments added to or changed the code. The most recent amendments to the regulations are contained in the Naval Petroleum Reserve Production Act of 1976, Public Law 94-258. These amendments and their impact on the Navy are discussed in Chapter 5 of the Navy Energy Plan.

PROPOSED LEGISLATION

The Petroleum Industry Competition Act (S. 2387)

The purpose of this bill is to require the "separation and divestment of assets and interests" by the 18 vertically integrated major petroleum companies in the United States. The major petroleum companies are Exxon, Texaco, Shell, Standard Oil of California, Standard Oil (Indiana), Gulf, Mobil, Atlantic-Richfield, Getty, Union, Sun, Phillips, Continental, Cities Service, Marathon, British Petroleum-S. Ohio, Amerada Hess, and Ashland Oil. Section 102 of the bill outlines the requirements for divestiture:

- Any *producer* producing a total of 36,500,000 barrels of crude oil condensate and liquified natural gas or whose interest in that production totaled 36,500,000 barrels during the calendar year is prohibited from owning or controlling any interest in refinery asset, transportation asset, or marketing asset.
- Any petroleum *transporter* is prohibited from owning or controlling any interest in any production asset, refinery asset, or marketing asset.
- Any *refinery* producing 75 million barrels of refined products or *marketer* marketing 110 million barrels of refined products is prohibited from owning or controlling any interest in any production or transportation asset.
- Any person owning a *refinery* asset, *production* asset, or *marketing* asset, is prohibited from transporting any energy resources in which he has an interest using any transportation asset in which he has an interest.

S. 2387 is just one of many divestiture bills which were introduced in the 94th Congress. However, recent action by the Senate Judiciary Committee to report S. 2387 out of committee for consideration by the full Senate makes this the most significant measure for consideration.

The impact of this legislation on the Navy, if it were to become law, would be dramatic. The major petroleum companies and DFSC have developed, over many years, an intricate distribution pattern to supply military installations with petroleum. If the provisions of S. 2387 were enacted, the resulting industry reorganization would disrupt the existing coordination and require DFSC to formulate an entirely new system.

In addition to the costs associated with formulating a new delivery system, vertical divestiture would most likely result in higher fuel prices because each of the four areas, production, transportation, refining, and marketing would be directed toward maximizing its individual profit.

Other problems anticipated include the possibility of longer supply lines and the loss of many small refineries that produce only JP-4. The movement of major oil companies into one of the four segments of the industry may cause the smaller refiners to assume the vacancies created by the major oil companies withdrawal, leaving some military bases without convenient fuel suppliers.

A concern shared by all petroleum consumers is that divestiture would result in increased dependence on foreign oil. This factor, combined with the slow development of alternative energy sources, would place the United States in a more vulnerable position than in 1973. During the 1973 embargo, major petroleum companies helped ease the impact on the United States by dividing the oil shortage between several countries. This style of support by the multinational corporations is unlikely to continue if the companies are forced to break up their U.S. holdings. Divestiture might also force the multinational companies to emphasize development of facilities in countries other than the United States.

Energy Information Act (S. 1864)

The intent of this legislation is to establish a National Energy Information Administration and to authorize the Department of Interior to survey U.S. energy resources. These measures are directed toward centralizing the collection, tabulation, comparison, analysis, standardization, and dissemination of energy information and eliminating duplicate efforts by various agencies. This function is presently performed by FEA.

The National Energy Information System provided for in this bill would function as the principal source of energy information for the federal government. Therefore, the Navy would have information available on corporate structure and proprietary relationships; fuel economics including capital investments and assets; energy supply and consumption data; and some geological information pertaining to energy reserves.

Electric Vehicle Research, Development, and Demonstration Act (H.R. 8800)

This bill authorizes an ERDA RD&D program to promote electric vehicle technology and to demonstrate the commercial feasibility of electric vehicles. As part of the administration of this program, ERDA may enter into arrangements and agreements with other federal agencies for assistance in the conduct of aspects of the program that are within their particular competence.

Specifically, the bill calls for the Secretary of Defense to arrange for the introduction of electric and hybrid vehicles into DOD's transportation fleet as soon as possible and to ensure that the maximum number of vehicles are in use.

In the Committee Report accompanying H.R. 8800, DOD's Army Tank-Automotive Command was cited for its support to other government agencies in the development of ground propulsion engines. This reference to DOD efforts serves to acknowledge the importance of DOD energy-related research and development programs.

Ground Propulsion Systems (H.R. 7231)

This bill would amend the Federal Nonnuclear Research and Development Act of 1974 to authorize research, development, and demonstration in the field of ground propulsion systems. The bill creates within ERDA a Division of Ground Propulsion Systems to "carry out all the research, development, and demonstration activities regarding ground propulsion systems, coordinating government and nongovernment research, including alternative energy sources."

To achieve the objectives of this proposed legislation, the act calls for the "effective utilization of the scientific and engineering resources of the United States already in existence, with close cooperation from NASA and all other interested agencies of the United States."